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NATIONAL DAM SAFETY PROGRAM. SPRINGVILLE DAM (INVENTORY NUMBER --ETC(U)
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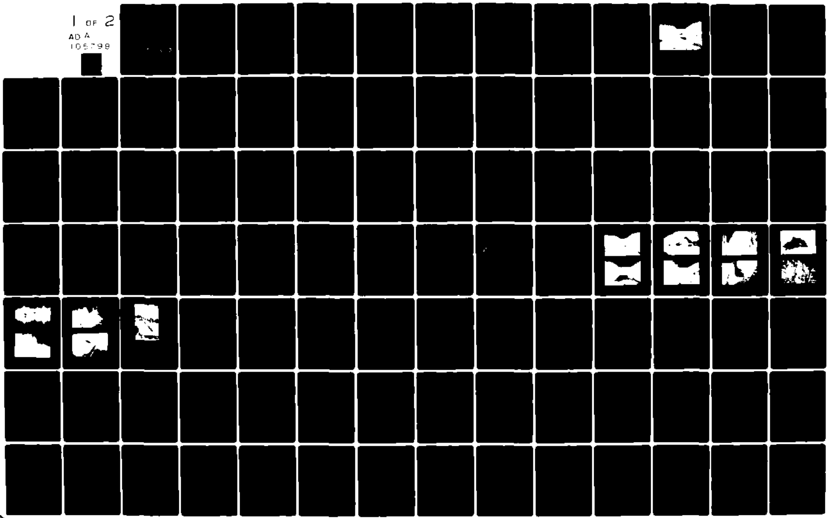

LAKE ERIE BASIN

SPRINGVILLE DAM

ERIE COUNTY, NEW YORK
INVENTORY No. N.Y. 704

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEW YORK DISTRICT, CORPS OF ENGINEERS

AUGUST 1981

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Springville Dam
Erie County
Lake Erie Basin

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

Examination of available documents and visual inspection of Springville Dam did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some deficiencies which require further investigation and remedial action.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The hydrologic/hydraulic analysis performed indicates that the spillway does not have sufficient capacity to discharge the peak outflow from one-half the Probable Maximum Flood (PMF). However, spillway discharges occurring during large storm events will cause water surface elevations in the downtown hazard area to rise to flood levels. A dam failure resulting from overtopping would not significantly increase the hazard to loss of life from that which would exist just prior to an overtopping failure. Therefore, the spillway is assessed as inadequate.

The original stability analysis for the spillway section of this dam could not be located. The structure relies on a combination of gravity and shear friction forces for stability. Analysis of such a structure is beyond the scope of a Phase I Investigation. In addition, the dam is located in Seismic Zone 3 and, in accordance with the Phase I Recommended Guidelines, a seismic stability analysis is warranted. Therefore, it is recommended that the services of a qualified registered professional engineer be retained to investigate the normal and seismic stability of the structure and the structural deficiences noted.

The investigation should be completed within 12 months of notification to the owner, and remedial actions resulting from the investigation completed in the subsequent 12 months.

The following remedial measures should be performed within one year of notification to owner:

- Repair the west sidewall of the spillway and the west core wall to restore them to their original configuration.
- Repair the eroded upstream channel banks by filling with suitable material.
- Install slope protection along both upstream channel banks to prevent future erosion.
- Clear trees and vegetation from the west embankment.
- Develop a formal written downstream warning system to alert the appropriate officials and residents in the event of an emergency.
- Develop and maintain a program of biannual technical inspections.

LAKE ERIE BASIN

SPRINGVILLE DAM

ERIE COUNTY, NEW YORK

INVENTORY No. N.Y. 704

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEW YORK DISTRICT, CORPS OF ENGINEERS

AUGUST 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the Investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event a finding that a spillway will not pass the Test Flood should not be interpreted as necessarily posing a highly inadequate condition. The Test Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

TABLE OF CONTENTS - con't.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Springville Dam
State Located:	New York
County Location:	Erie
Stream:	Chattaraugus
Basin:	Lake Erie
Date of Inspection:	May 22, 1981

ASSESSMENT

Examination of available documents and visual inspection of Springville Dam did not reveal conditions which constitute an immediate hazard to human life or property. However, the dam has some deficiencies which require further investigation and remedial action.

The hydrologic/hydraulic analysis performed indicates that the spillway does not have sufficient capacity to discharge the peak outflow from one-half the Probable Maximum Flood (PMF). However, spillway discharges occurring during large storm events will cause water surface elevations in the downtown hazard area to rise to flood levels. A dam failure resulting from overtopping would not significantly increase the hazard to loss of life from that which would exist just prior to an overtopping failure. Therefore, the spillway is assessed as inadequate.

The original stability analysis for the spillway section of this dam could not be located. The structure relies on a combination of gravity and shear friction forces for stability. Analysis of such a structure is beyond the scope of a Phase I Investigation. In addition, the dam is located in Seismic Zone 3 and, in accordance with the Phase I Recommended Guidelines, a seismic stability analysis is warranted. Therefore, it is recommended that the services of a qualified registered professional engineer be retained to investigate the normal and seismic stability of the structure and the structural deficiences noted.

The investigation should be completed within 12 months of notification to the owner, and remedial actions resulting from the investigation completed in the subsequent 12 months.

The following remedial measures should be performed within one year of notification to owner:

- Repair the west sidewall of the spillway and the west core wall to restore them to their original configuration.
- Repair the eroded upstream channel banks by filling with suitable material.
- Install slope protection along both upstream channel banks to prevent future erosion.
- Clear trees and vegetation from the west embankment.
- Develop a formal written downstream warning system to alert the appropriate officials and residents in the event of an emergency.
- Develop and maintain a program of biannual technical inspections.

Robert J. Farrell, P.E.
New York No. 55983

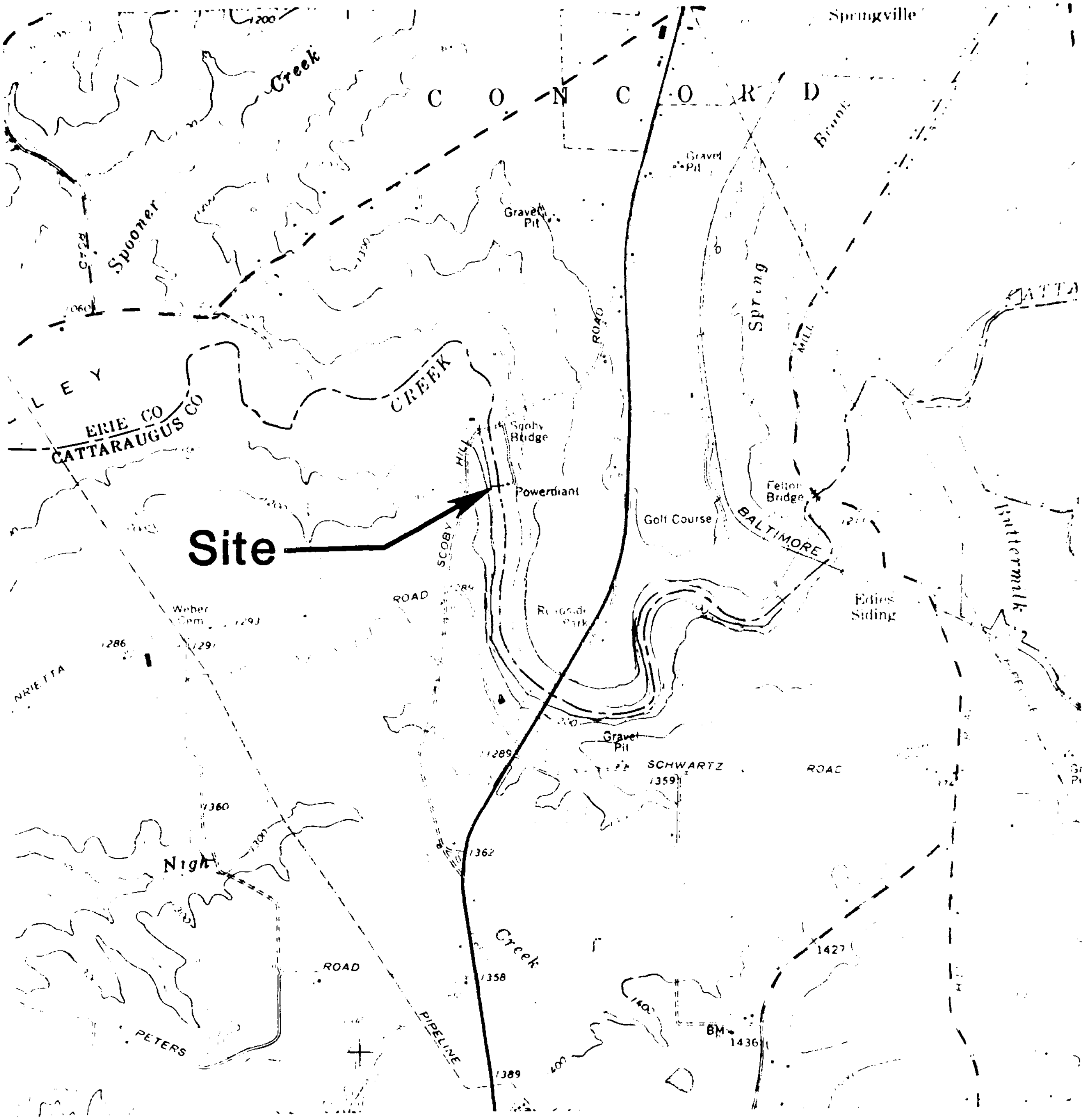
Approved by:

Col. W.M. Smith, Jr.
New York District Engineer

Date: 27 Aug 81

Springville Dam

OVERVIEW



Springville Dam

LOCATION PLAN

Scale: 1" = 2000'

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

SPRINGVILLE DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the New York District Corps of Engineers in a letter dated 24 February 1981, in fulfillment of the requirements of the National Dam Inspection Act, Public Law 92-367, dated 8 August 1972.

b. Purpose of Inspection

This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF THE PROJECT

a. *Description of Dam and Appurtenances*

The dam consists of an earth embankment with a concrete core wall and a concrete ogee spillway section. There is an intake flume, forebay, powerhouse, and tail race located at the east end of the spillway near the center of the dam. The overall length of the dam is approximately 388 ft. Springville Dam is located immediately downstream from a wood dam constructed in the late 1800's. The wood dam is not visible when the water surface is at the ogee spillway crest.

An earth embankment with a 1.5 ft. thick concrete core wall extends from the forebay to the east abutment, and from the west end wall to the west abutment. The core wall is approximately 2.5 ft. higher than the top of the earthfill. According to available design information, the core wall is founded in rock, and existing embankments from a previous dam were used as berms.

The east embankment and core wall extends 118.5 ft. at elevation 1105.6 ft. (MSL). There is a 17.8 ft. opening in the section to permit vehicle passage. The opening was covered with wood flashboards to elevation 1103.8 ft. (MSL). The side slope of the valley at the east abutment is 1V:1½H. The west embankment and core wall extends 44.5 ft. at elevation 1107.4 ft. (MSL). A level section of embankment extends another 15.0 ft. before intersecting the 1V:1½H valley side slope.

The concrete ogee spillway section is 182.0 ft. long and 15 ft. high. There are three 5.0 ft. x 6.0 ft. wide openings in the spillway at the apron elevation of 1069.4 ft. (MSL). These openings are covered by wood beams. Once a year, during the summer months, the reservoir is drained by setting off a charge of dynamite in each of these openings. The operating head in the reservoir is increased during the summer months by approximately 33 in. by placing flashboards across the crest of the spillway.

The intake flume, forebay, powerhouse, and tailrace are located at the east end of the spillway. The intake flume is 11.0 ft. wide, contains a trash rack at the upstream end, and a stop log at the downstream end where it connects to the forebay. The forebay is 43.5 ft. long, 13 ft. wide at the upstream end, and 15 ft. wide at the downstream end. The 12.2 ft. long x 31.5 ft. wide distribution chamber feeds two 6.0 ft. diameter tubes that feed the 2 turbines. These tubes are equipped with butterfly valves. The tailrace is 28.8 ft. wide at the downstream end of the powerhouse, and tapers to 15.0 ft. at a point of 40.0 ft. downstream.

b. Location

The dam is located approximately 2 miles southwest of the Village of Springville, New York in the Town of Concord.

c. Size Classification

The dam is 40 ft. high as measured from the top of the west core wall to the channel invert. The reservoir has a storage capacity of 1170 acre-ft. at the top of the west core wall (elevation 1106.1 ft. (MSL)). The dam is classified as "INTERMEDIATE" in size (40 to 100 ft. in height).

d. Hazard Classification

The dam is classified as HIGH hazard due to the significant economic losses and high potential for loss of life downstream in the event of dam failure.

e. Ownership

The dam is owned and operated by:

The Village of Springville
Mr. John Lipoff, Water & Light Superintendent
243 North Central Street
Springville, New York 14141
Tele: (716) 592-4722

f. Purpose of Dam

The purpose of this dam is to generate hydroelectric power for the Village of Springville. The powerhouse is presently equipped with two 250KW generators.

g. Design and Construction History

The dam was designed by the Village of Springville Engineer, L.W., Bernstein Consulting Enginners, and the Corrugated Bar Company. For this inspection, copies of correspondence, records, 6 design drawings, 4 sheets of design calculations for the forebay, and a hydrograph of a historic flood on Cattaragus Creek were provided by the New York State Department of Environmental Conservation, Albany, New York.

The dam was constructed in 1921 by the Walter Bradley Construction Company. No records of the construction history are available.

h. Normal Operation Procedure

Water is released from the reservoir through the power generation facilities, and any excess is released over the uncontrolled ogee spillway section.

1.3 PERTINENT DATA

a. Drainage Area - 280 sq. miles

b. Discharge at Damsite

Maximum known flood at damsite	Unknown
Maximum discharge in last 26 years (according to Mr. John Lipoff, Superintendent of the Electric Department of the Village of Springville	14,251 cfs
Principal Spillway	
Maximum Pool (elevation 1103.8 ft.(MSL))	23,192
Power Generation Facilities (Not operated during flood events)	
Maximum Pool (elevation 1103.8 ft(MSL))	0
Total Spillway Capacity at Maximum Pool Elevation	23,192

c. Elevation (U.S.G.S. Datum)

Top of east endwall	1108.2 ft.
Top of west endwall	1107.4 ft.
Top of west core wall	1106.1 ft.
Top of east core wall	1105.6 ft.
Top of opening in east core wall	1103.8 ft.
Top of west embankment	1106.1 ft.
Ogee spillway crest	1093.7 ft.

d. <u>Reservoir</u>

Length of Normal Pool	8000 ft.
Length of Maximum Pool	12500 ft.

e. <u>Storage</u>

Normal Pool	52 acre-ft.
Maximum Pool	1170 acre-ft.

f. <u>Reservoir Surface</u>

Normal Pool	22 acres
Maximum Pool	92 acres

g. <u>Dam</u>

Type	Earth embankment with concrete core wall and gravity concrete ogee spillway.
Length	388 ft.
Maximum Height	40 ft.

h. <u>Reservoir Drains</u> (3)

Type	Openings in concrete ogee spillway.
Size	5.0 ft. high x 6.0 ft. wide
Closure	Wood beams

i. <u>Principal Spillway</u>

Type	Concrete gravity ogee crest
Length	182 ft.
Location	Near center of reservoir
Support	Bedrock
Downstream	Reinforced concrete apron

j. <u>Emergency Spillways</u>

Type	Embankment with core wall
Length:	
East core wall	118.5 ft.
East core wall opening with flashboards	17.8 ft.
West core wall	44.5 ft.
West embankment (no core wall)	25.0 ft.
Side Slope	1V:2H

SECTION 2 - ENGINEERING DATA

2.1 GEOLOGY

The stratigraphy in southern Erie County consists of relatively undeformed flat-lying sedimentary rocks of Upper Devonian Age (375-345 million years ago). The bedrock formations are interbedded shales and siltstones of the Canadaway Group, Gowanda Shale Member. The bedrock is an interbedded gray to black silty shale, and thin to thick bedded light gray siltstone forming a homocline which dips southward to southwestward at approximately 40 feet per mile. Small terraces and low folds locally modify this dip to essentially flat-lying over short distances. Only minor folding and faulting are found in the region with no major or active faults known to exist in the area.

The Village of Springville and the Springville Dam are in a region classified as Zone 3 seismicity, as shown on Figure No. 1 of the Recommended Guidelines for Safety Inspection of Dams.

Glaciation of the area was extensive. During the glacial period (Pleistocene Epoch), spanning about 1.5 million years, the area was over-ridden many times by a thick continental ice sheet moving southward over the region, from Quebec and Ontario, eroding the rock and changing drainage patterns. Deposition is by strongly aggrading streams flowing from the former ice sheets. Coarse alluvium is deposited in coalescent aprons near the ice sheet, and/or as valley trains, where streams, drain freely from the glacier margin. In recent times, these glacial deposits are infiltrating the valleys with alluvial material eroded from the uplands.

2.2 SUBSURFACE INVESTIGATION

According to the application for reconstruction of the dam dated August 10, 1921, there were no subsurface surveys conducted in conjunction with the project. The application states that the dam is founded on horizontally bedded argillaseous shale.

2.3 DESIGN RECORDS

The records available for the project consists of 6 design drawings which show the plans, section and details of the spillway, intake flume, forebay, powerhouse and tailrace. There are also several letters that discuss the design of the dam, 4 sheets of design calculations for the forebay, and a hydrograph of a historic flood on Cattaragus Creek. These records are on file with the New York State Department of Environmental Conservation, Albany, New York.

2.4 CONSTRUCTION RECORDS

There are no construction records for this dam.

2.5 OPERATION RECORDS

No written maintenance or operation records exist for the dam

2.6 EVALUATION OF DATA

Information obtained from the design drawings is consistent with observations made during this inspection. The information obtained from available data was considered adequate for the Phase I inspection and evaluation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

A visual inspection of Springville Dam was made on May 22, 1981. The weather was clear and the temperature was in the mid-seventies. At the time of the inspection, the impoundment level was at the crest of the dam, elevation 1093.7 ft. (MSL).

b. Earth Embankment

The top corners of the east core wall are moderately spalled over most of the wall length. Hairline cracks and effervescent stains cover 75 percent of the exposed surface area.

The east earth embankment is in good condition and is well-maintained. However, significant erosion was noted at the upstream end of the east spillway side wall resulting from the recent uprooting of a large tree. Light seepage was noted along the east side of the powerhouse.

The west core wall is seriously deteriorated. The entire top surface and 80 percent of the exposed side surfaces are spalled. At many locations in excess of 6 in. of concrete has spalled off.

There are many trees and thick vegetation growing on the west embankment.

c. Foundation

Bedrock at the site consists of a mixture of siltstones and silty shales. The rock is medium hard, thinly to very thinly bedded, fine grained, medium gray to gray-green, highly fissile shale/siltstone mixture with abundant zones of argillacevous rock. At the powerhouse, there is a horizontal seam approximately 3 ft. above the water surface. This seam is open and moderately weathered with rust precipitation staining the rock. Minor weeps exit the seam in isolated areas.

At the east downstream end of the concrete apron, rock erosion was noted. A hole approximately 2 ft. deep extends under the apron approximately 1 ft.

d. Spillway

The ogee spillway and both endwalls were resurfaced with gunite and wire mesh sometime after the dam was built. The spillway is in good condition; although minor cracking, spalling, surface erosion and gunite layer separation was observed. The west endwall is in poor condition. Approximately 90 percent

of the gunite has fallen off leaving the original heavily deteriorated concrete surface exposed. The east endwall, which is integral with the powerhouse intake structure, is covered with hairline cracks and effervescent stains. Evidence of recent surface patching was observed.

Across the crest of the dam there are steel stanchions approximately 30 in . high on 3 ft. centers. They support wood flashboards. At the time of the inspection all the stanchions were bent over and no flashboards were in place. According to the owner's representative, the stanchions and flashboards fail annually due to ice loads and are replaced during periods of low flow.

e. Downstream Channel

The downstream channel is gradually sloping bedrock. There is some debris in the channel. The soil cover on the banks shows signs of creep as the trees have a slight bow. An abandoned penstock has been partially filled with overburden.

f. Reservoir

The shore of the reservoir is generally medium to steeply sloping woodland. Although there has been some erosion at the waterline, the banks appear stable.

3.2 EVALUATION

Visual observations made during the course of the inspection did not indicate any serious problems which would adversely affect the adequacy of the dam. The following is a summary of the problem areas encountered in order of importance:

1. The gunite resurfacing of the west endwall of the spillway is highly deteriorated.
2. Significant erosion exists along the east channel bank at the upstream end of the east endwall of the spillway.
3. The west concrete core wall is heavily deteriorated.
4. Rock erosion (undermining) is occurring along the downstream edge of the concrete apron.
5. Trees and vegetation cover the west embankment.

SECTION 4 - OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

No written operation and maintenance procedures exist for the project. The normal operation of the project consists of relieving water from the reservoir through the power generation facilities, and spilling any excess over the ogee spillway section.

4.2 WARNING SYSTEM IN EFFECT

No warning system is in effect or in preparation.

4.3 EVALUATION

The overall condition of the dam and appurtenant structures appears to be fair. Recommendations in connection with regular maintenance are discussed in Section 7.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE AREA CHARACTERISTICS

Springville Dam is located on Cattaraugus Creek in the Lake Erie basin, and has a drainage area of 280 square miles. The dam is situated approximately 2 miles southwest of the Village of Springville, New York. The topography of the watershed is rolling plateau, with woods and pastures.

5.2 DESIGN DATA

There exist no detailed computations for the design flow of this dam. The design flow for the dam according to a letter from the State Inspector of Docks and Dams to the State Engineer dated August 15, 1921 is 30,800 cfs (0.2 cfs/acre) and would overflow the crest of the spillway at a height of 13 ft. This height corresponds to elevation 1106.7 ft. (MSL). The abutment of the dam was given as 14.0 ft. The principal spillway consists of a 182 ft. concrete ogee section, at elevation 1093.7 ft. (MSL). On the east side of the spillway there is a concrete end wall at elevation 1108.2 ft. (MSL) that connects to the brick powerhouse and intake structure. The powerhouse contains two units with a total capacity of 500 Kw. A 1.5 ft. wide concrete core wall extends to the east for a distance of 118.5 ft. at elevation 1105.6 ft. (MSL). There is a 17.8 ft. opening in the wall with flashboards at elevation 1103.8 ft. (MSL). The core wall then extends into valley wall. On the west side of the spillway there is a concrete end wall at elevation 1107.4 ft. (MSL). A 1.5 ft. wide concrete core wall, 44.5 ft. in length, extends to the west at elevation 1106.1 ft. (MSL) and ties into the valley wall. There are three 5.0 ft. high x 6.0 ft. wide openings in the spillway at the apron elevation of 1069.4 ft. (MSL). Neither they nor the penstocks to the powerhouse were assumed to convey flow during the floods considered in this analysis.

5.3 ANALYSIS CRITERIA

The analysis of the spillway capacity of the dam and the storage of the reservoir was performed using the Corps of Engineers HEC-1 Dam Safety Version computer model. The unit hydrograph was defined by the Snyder Synthetic Unit Hydrograph method. Runoff from each of 4 sub-areas was routed by the muskingum routing method to the reservoir. The Modified Puls routing procedure was used to route the floods through the reservoir. The Probable Maximum Precipitation (PMP) was 22.2 in. (24 hours, 200 sq. miles) from Hydrometerological Report #33 in accordance with the Recommended Guidelines of the Corps of Engineers. The top of the west core wall is 40 ft. high and impounds approximately 1170 acre-ft. The PMF inflow of 148,276 cfs was routed through the reservoir and the peak outflow was determined to be 148,018 cfs. The peak PMF elevation is 1120.9 ft. (MSL) or 14.8 ft. above the top of the west core wall. The maximum elevation for one half the PMF is 1112.6 ft. (MSL) or 6.5 ft. above the top of the west core wall. The inflow and outflow for one half the PMF are 74,138 cfs and 74,054 cfs, respectively.

5.4 RESERVOIR CAPACITY

The reservoir capacities at the crest of the spillway and at the top of the west core wall are 52 acre-ft. and 1170 acre-ft., respectively. Surcharge storage between the spillway crest and the top of the west core wall is equivalent to 0.07 in. of runoff from the drainage area.

5.5 EXPERIENCE DATA

There are no flood records for the dam site. However, according to Mr. John Lipoff, Superintendent of the Electric Department of the Village of Springville, the highest water elevation observed in the last 26 years was approximately 7 ft. above the crest of the spillway (elevation 1101 ft. (MSL)). This reservoir elevation corresponds to a peak outflow of 14,251 cfs.

5.6 OVERTOPPING POTENTIAL

The maximum capacity of the spillway is 23,192 cfs (at elevation 1103.8 ft. (MSL)) which is less than the PMF peak outflow of 148,018 cfs. The dam is overtopped by the PMF and one half the PMF, the peak elevations being 14.8 ft. and 6.5 ft. above the top of the west core wall, respectively. The spillway will pass approximately 15 percent of the PMF.

5.7 ANALYSIS OF DOWNSTREAM IMPACTS

During the field investigation, dwellings and highways located downstream of the dam were identified and referenced to the channel invert. The cross section locations used in the downstream channel routing are shown beginning on Page D-2, Appendix D. The impacts of the PMF on dwellings located downstream of the dam are shown in Table 5.1. For the purposes of this analysis, a danger of loss of life was assumed to exist if the computed PMF water surface was above the first floor elevation of a structure. This situation occurs at several of the structures and 3 roads are overtopped during the PMF. These results show that the potential danger of loss of life and economic damage is substantial enough to warrant classification as a HIGH hazard dam.

5.8 EVALUATION

The spillway of Springville Dam will safely pass only 15 percent of the PMF without overtopping. The spillway, therefore, is assessed as inadequate, but not seriously inadequate.

ETL 1110-2-234, Section 5, gives the basis for determining whether or not a spillway should be classified as seriously inadequate. The results of this investigation indicate that there would not be a significant increase in the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. This is illustrated by the elevation-discharge relationship shown in Figure 5.1. The increase in flow above the crests of the east and west core walls does not appear to be significant, therefore the spillway is assessed as inadequate. Potential problems include:

a) The danger of loss of life and economic damage downstream of the dam for floods in the 1/2 PMF to PMF range.

TABLE 5.1

SUMMARY OF DOWNSTREAM IMPACTS FOR PMF

Location # (See pg. D-2, Appendix D)	Location	# of Dwellings	Structure Height Above Streambed* (ft)	Peak Flow (cfs)	Peak Stage (ft)	Comments
-	At Dam	-	-	148,018	-	-
1	1000 ft. d/s of Dam	1	19.2	148,010	34.7	Danger of loss of life Road over-topped
2	1000 ft d/s of Loc. 1	1	15	148,018	27.2	Danger of loss of life
3	5100 ft. d/s/ of Loc. 2	-	-	148,084	29.3	-
4	2720 ft. d/s of Loc. 3	-	-	148,161	26.2	-
5	4200 ft. d/s of Loc. 4	1	25	148,186	24.2	-
6	3800 ft. d/s of Loc. 5	3	21	148,117	29.4	Danger of loss of life
7	900 ft. d/s of Loc. 6	1	23	148,045	25.7	Danger of loss of life Road over-topped.

TABLE 5.1 - con't

SUMMARY OF DOWNSTREAM IMPACTS FOR PMF

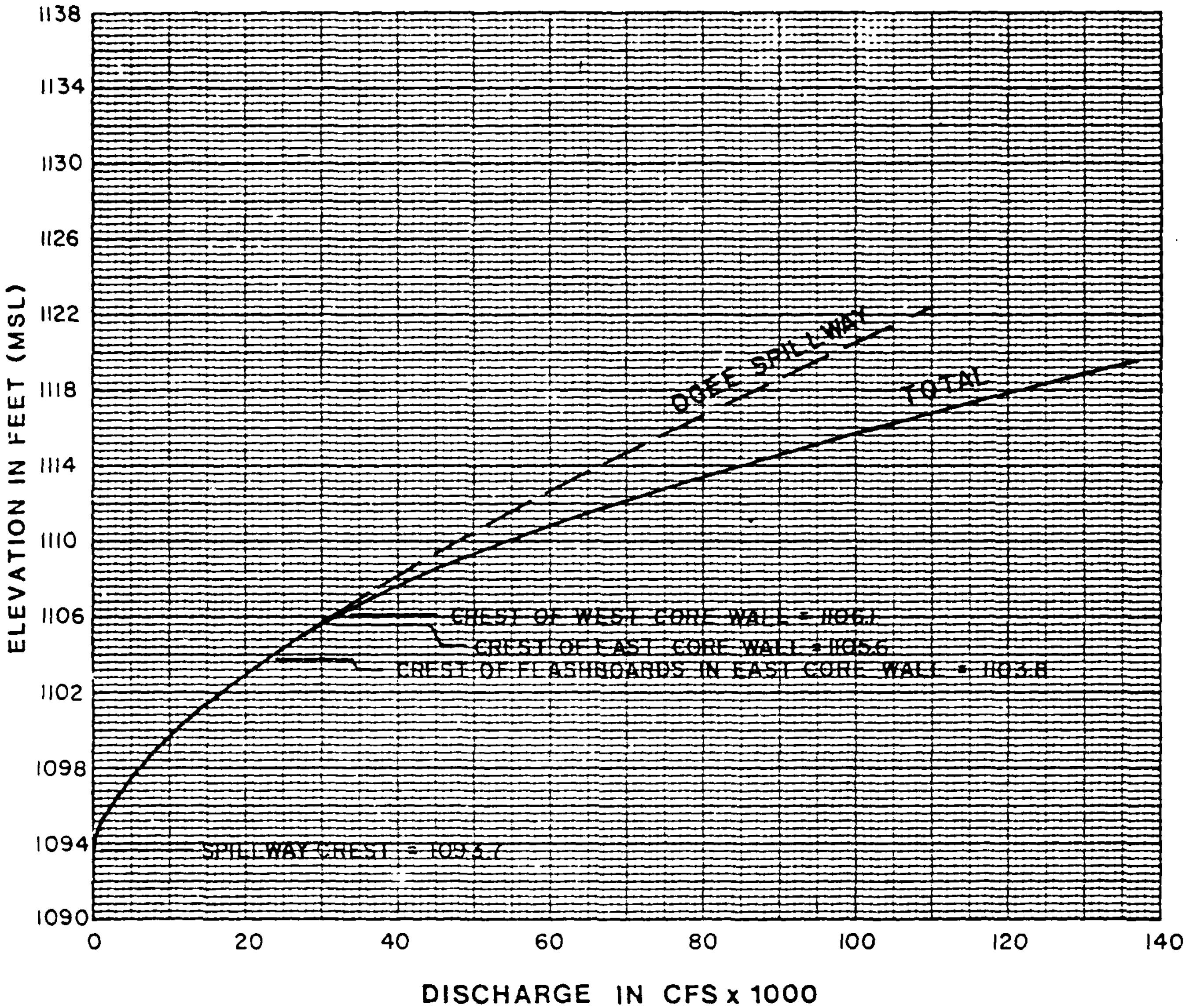
Location (See pg. D-2, Appendix D)	Location	# of Dwellings	Structure Height Above Streambed* (ft)	Peak Flow (cfs)	Peak Stage (ft)	Comments
8	1000 ft. d/s of Loc. 7	2 trailer 2 1	7 7 10	148,053	18.9	Danger of loss of life
9	2700 ft d/s of Location 8	1 cottage 2 trailers 3 trailers 2 1 1 1	5 8 5 7 11 15 5	148,116	23.5	Danger of loss of life
10	7300 ft. d/s of Loc. 9	-	-	148,127	34.3	-
11	4840 ft. d/s of Loc. 10	-	-	148,164	30.8	-
12	7900 ft. d/s of Loc. 11	-	-	148,015	32.2	-
13	3800 ft. d/s of Loc. 12	1 cottage	20	148,084	24.6	Danger of loss of life
14	3300 ft. d/s of Loc. 13	1	15	148,042	19.0	Danger of loss of life

TABLE 5.1- cont

SUMMARY OF DOWNSTREAM IMPACTS FOR PMF

Location # (See pg. D-2, Appendix D)	Location	# of Dwellings	Structure Height Above Streambed* (ft)	Peak Flow (cfs)	Peak Stage (ft)	Comments
15	3000 ft. d/s of Loc. 14	1 Restaurant 1 1	11 11 20	147,940	24.0	Danger of loss of life Road over-topped.
16	3300 ft. d/s of Loc. 15	1	13	148,039	21.6	Danger of loss of life.
17	1700 ft. d/s of Loc. 16	1	20	147,976	24.2	Danger of loss of life.

* The structure height above the streambed is the difference between the first floor elevation and the channel invert.



SPRINGVILLE DAM (N.Y. 704)

RATING CURVE

PHASE I DAM INSPECTION REPORT

DATE: JULY, 1981 | FIGURE 5.1

SECTION 6 - STRUCTURAL STABILITY

6.1 VISUAL OBSERVATIONS

No significant displacement or distress associated with the embankment or structures was observed during this Phase I Inspection. There has been some loss of ground at the upstream face of embankment at the east spillway endwall, and rock erosion below the east end of the apron.

6.2 DESIGN AND CONSTRUCTION DATA

No records of structural stability analyses are available for this dam.

6.3 POST-CONSTRUCTION CHANGES

Since the dam was constructed, the forebay has been modified and the entire spillway has been resurfaced with gunite.

6.4 SEISMIC STABILITY

The dam is located in Seismic Zone 3 and, in accordance with the recommended Phase I guidelines, a seismic stability analysis is warranted. This should be accomplished by a qualified registered professional engineer and should be made a part of the record for this dam.

6.5 STRUCTURAL STABILITY ANALYSIS

The configuration of the spillway section of the dam and the integral apron makes reasonable prediction of the failure made for the dam virtually impossible without obtaining pertinent additional information regarding the rock and concrete material properties. Furthermore, the dam cannot be analyzed as a pure gravity dam, since it relies on a combination of gravity and substantial shear friction for stability. Investigation of such a structure is beyond the scope of this Phase I Investigation. Therefore, it is recommended that an in-depth investigation of the structural stability of the dam be conducted. That investigation should include the following:

1. The actual magnitude and distribution of hydrostatic uplift pressures under the dam should be determined by installing and monitoring piezometers.

2. Core samples of the dam and foundation rock should be taken to determine in situ material properties.

SECTION 7 -ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety

Examination of the available documents and the visual inspection of Springville Dam did not reveal conditions which constitute an immediate hazard to human life or property. The concrete dam is considered to be stable under present conditions.

The spillway is inadequate based on the Corps of Engineers Recommended Guidelines. It will safely pass neither the PMF nor 1/2 the PMF without overtopping.

The dam is located in Seismic Zone 3; there is no record of a seismic stability analysis being performed.

b. Adequacy of Information

The information reviewed is considered adequate for a Phase I Inspection.

c. Need for Additional Investigations

It is recommended that the services of a qualified registered professional engineer be retained to:

1. Investigate the source of seepage through and around the powerhouse, and determine the proper method of sealing this seepage.

2. Evaluate the rock erosion along the downstream edge of the concrete apron and recommend appropriate remedial measures.

3. Investigate the normal and seismic structural stability of the spillway section of the dam.

d. Urgency

The investigations should be completed within 12 months of notification to the owner, and remedial actions resulting from these investigations completed in the subsequent 12 months. The remedial measures or actions listed below should be completed within one year from notification.

7.2 RECOMMENDED MEASURES

1. Implement those remedial measures or actions resulting from the aforementioned investigations.

2. Repair the west sidewall of the spillway and the west core wall to restore them to their original configuration.

3. Repair the eroded upstream channel banks by filling with suitable material.

4. Install slope protection along both upstream channel banks to prevent future erosion.

5. Clear trees and vegetation from the west embankment.

6. Develop a formal written downstream warning system to alert the appropriate officials and residents in the event of an emergency.

7. Develop and maintain a program of biannual technical inspections.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam Springville

Fed. I.D. # NY00704 DEC Dam No. 19A-565

River Basin Erie

Location: Town Concord County Erie

Stream Name Cattaraugus

Tributary of Lake Erie

Latitude (N) 42^{o}19.0' Longitude (W) 78^{o} 42.1'

Type of Dam Concrete and earth embankment with core wall

Hazard Category High

Date(s) of Inspection May 20, 1981

Weather Conditions Sunny, 70^{o}

Reservoir Level at Time of Inspection 1093.7 ft. (MSL)

b. Inspection Personnel Jeffrey Hardin, Ray Kampff, Bob Farrell, Ken Avery, Bidjan Rostami

c. Persons Contacted (including Address & Phone No.) Mr. John Lipoff
Supt. of Electric Dept.
Village of Springville
Nason Blvd. (716)555-1212

d. History:

Date Constructed 1921 Date(s) Reconstructed

Designer Corrugated Bar Company, L.S. Bernstein Consulting Engineers, Village Engineer

Constructed by Bradley Construction Company

Owner Village of Springville

) Embankment

a. Characteristics

(1) Embankment Material Clay and sand mixture.

(2) Cutoff Type Corewall keyed into rock.

(3) Impervious Core Concrete corewall.

(4) Internal Drainage System Unknown

(5) Miscellaneous

b. Crest

(1) Vertical Alignment Good

(2) Horizontal Alignment Good

(3) Surface Cracks None

(4) Miscellaneous

c. Upstream Slope

(1) Slope (Estimate) (V:H) variable, maximum 1 vertical:1.5 horizontal

(2) Undesirable Growth or Debris, Animal Burrows A few large trees (12 in.) one uprooted near right endwall.

(3) Sloughing, Subsidence or Depressions None noted

(4) Slope Protection None

(5) Surface Cracks or Movement at Toe None noted

d. Downstream Slope

(1) Slope (Estimate - V:H) Variable

(2) Undesirable Growth or Debris, Animal Burrows

(3) Sloughing, Subsidence, or Depressions Some loss of ground near right side of powerhouse.

(4) Surface Cracks or Movement at Toe

(5) Seepage Light seepage emanating from east side of powerhouse

(6) External Drainage System (Ditches, Trenches, Blanket) None noted

(7) Condition Around Outlet Structure Some seepage and loss of ground near powerhouse

(8) Seepage Beyond Toe None noted

e. Abutments - Embankment Contact

Left abutment was observed from the right abutment due to difficulty of access.

(1) Erosion at Contact None noted

(2) Seepage Along Contact None noted

3) Drainage System

(a) Description of System None

(b) Condition of System Not applicable

(c) Discharge from Drainage System Not applicable

4) Instrumentation (Momumentation/Surveys, Observation Wells, Weirs, Piczometers, etc.) None

5) Reservoir

a. Slopes Generally good condition, some minor erosion

b. Sedimentation has occurred up to the top of one of the reservoir drains (5.0 ft.)

c. Unusual Conditions Which Affect Dam None noted

6) Area Downstream of Dam

a. Downstream Hazard (No. of homes, highways, etc) Refer to Table 5.1 for a list of downstream impacts

b. Seepage, unusual growth Minor weeps in exposed bedrock along the right bank.

c. Evidence of movement beyond toe of Dam None

d. Conditions of Downstream Channel Rock strewn, wide, good condition

7) Spillway(s) (including Discharge Conveyance Channel)

Concrete ogee spillway; resurfaced with gunite

a. General Good except for west endwall which is in poor condition

b. Condition of Service Spillway Good; minor cracking, spalling, erosion & gunite layer separation

c. Condition of Auxiliary Spillway Not applicable

d. Condition of Discharge Conveyance Channel Not applicable

8) Reservoir Drain/Outlet

Type: Pipe ______ Conduit ______ Other (3) 5'x6' openings

Material: Concrete X Metal ______ Other ______

Size: 5' x 6' Length ______

Invert Elevations: Entrance 1069.4 MSL Exit 1069.4 MSL

Physical Condition (Describe): Unobservable ______

Material: Good

Joints: ______ Alignment ______

Structural Integrity: Good

Hydraulic Capability: No impairments

Means of Control: Gate ______ Valve ______ Uncontrolled ______

Operation: Operable ______ Inoperable ______ Other ______

Present Condition (Describe): Wood lagging; opened by dynamite; saturated

9) Structural

a. Concrete Surfaces Generally good; west wall of spillway poor; 90% of gunite has fallen off

b. Structural Cracking Minor on spillway & intake structure

c. Movement - Horizontal & Vertical Alignment (Settlement) None observed

d. Junctions with Abutments or Embankments Could not inspect

e. Drains - Foundation, Joint, Face None

f. Water Passages, Conduits, Sluices Good

g. Seepage or Leakage Light seepage emanating from east side of powerhouse

h. Joints - Construction, etc. Good

i. Foundation On rock, erosion at east end of apron

j. Abutments Not applicable

k. Control Gates None - Butterfly valves located in powerhouse

l. Approach & Outlet Channels See intake structure. Spalling on tail race concrete

m. Energy Dissipators (Plunge Pool,etc) None

n. Intake Structures Forebay has many surface cracks but is well maintained

o. Stability Good. No problems observed

p. Miscellaneous

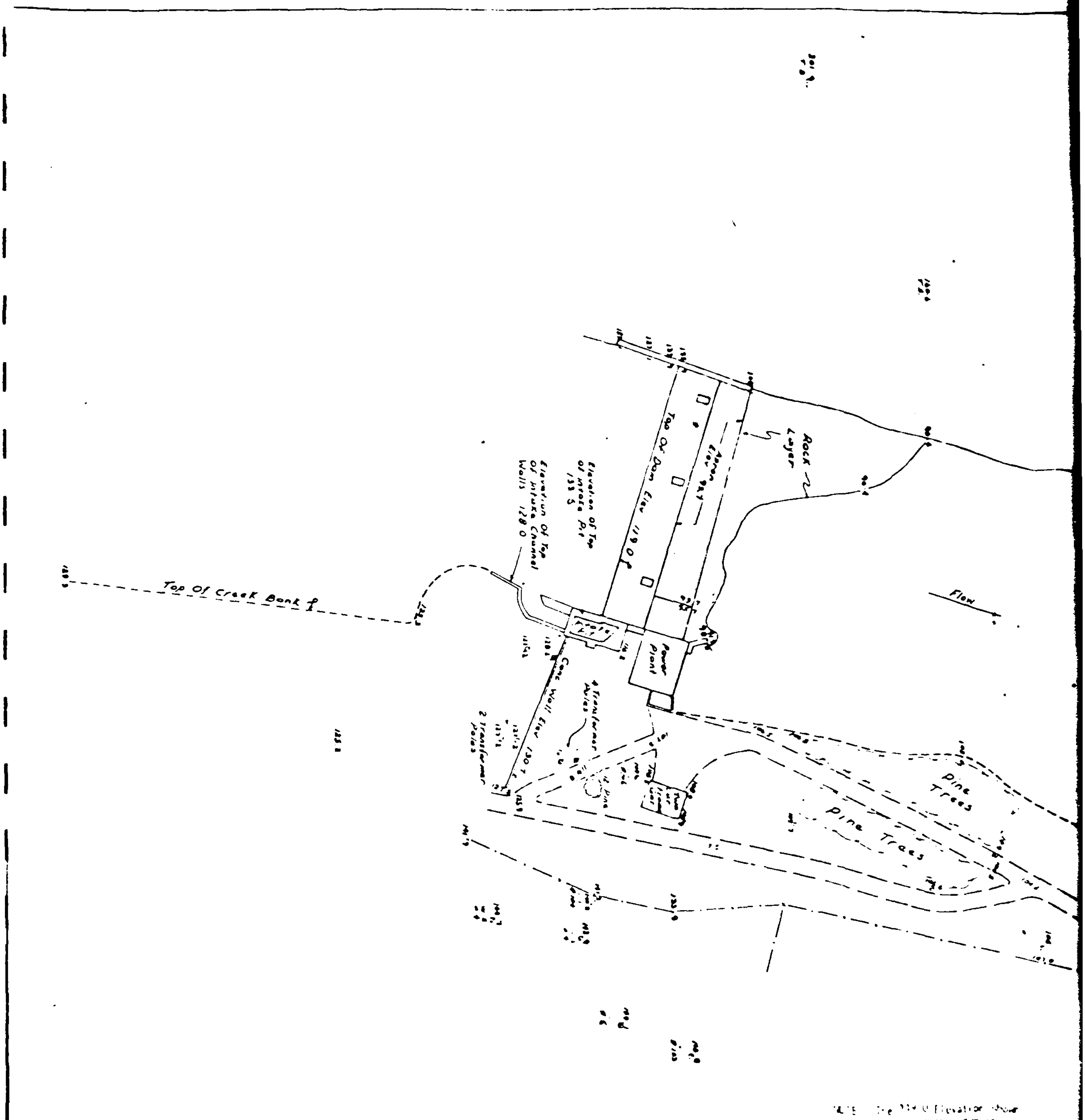
10) Appurtenant Structures (Power House, Lock, Gatchouse, Other)

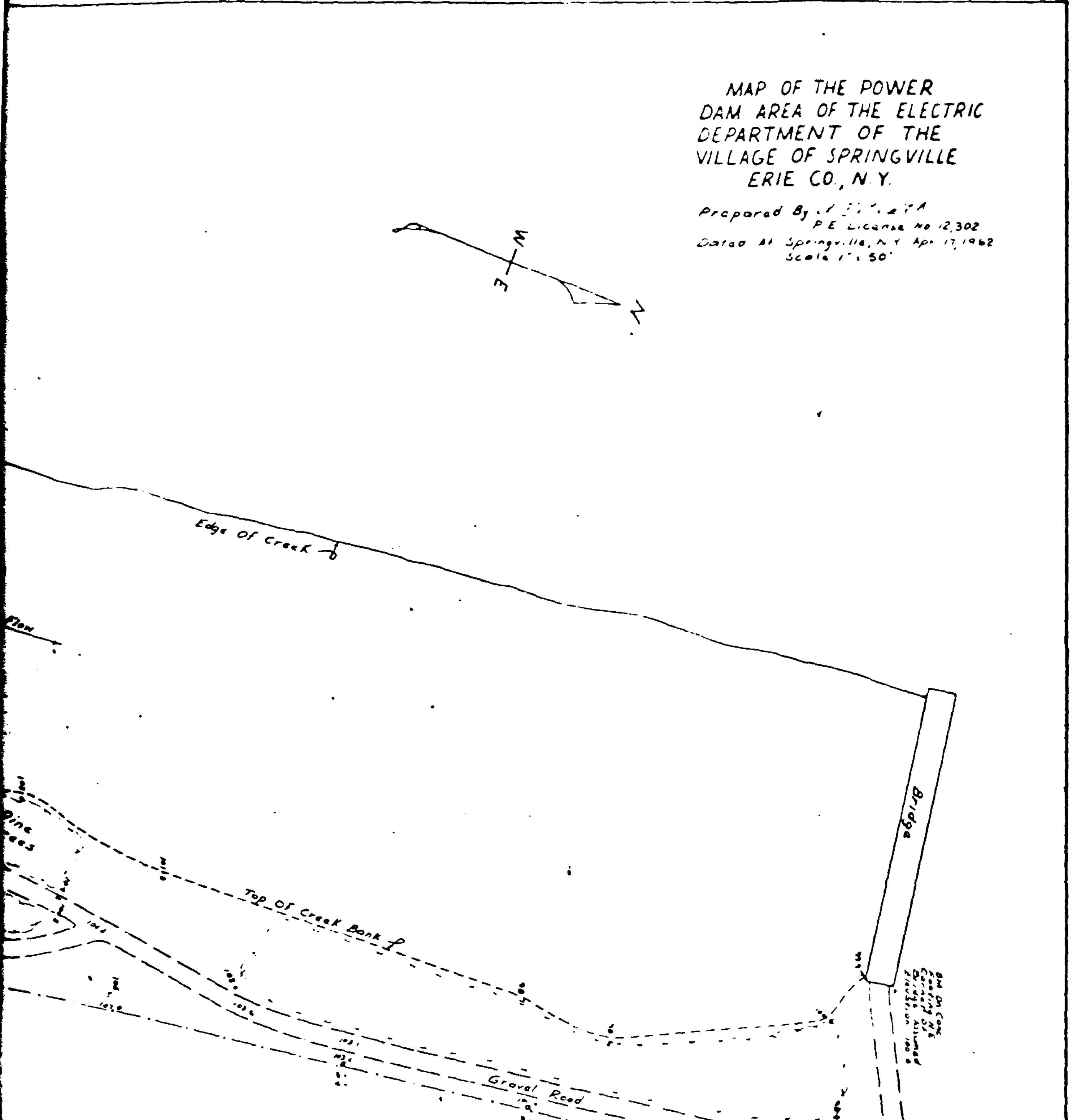
a. Description and Condition Powerhouse is in good condition

APPENDIX B

ENGINEERING DATA

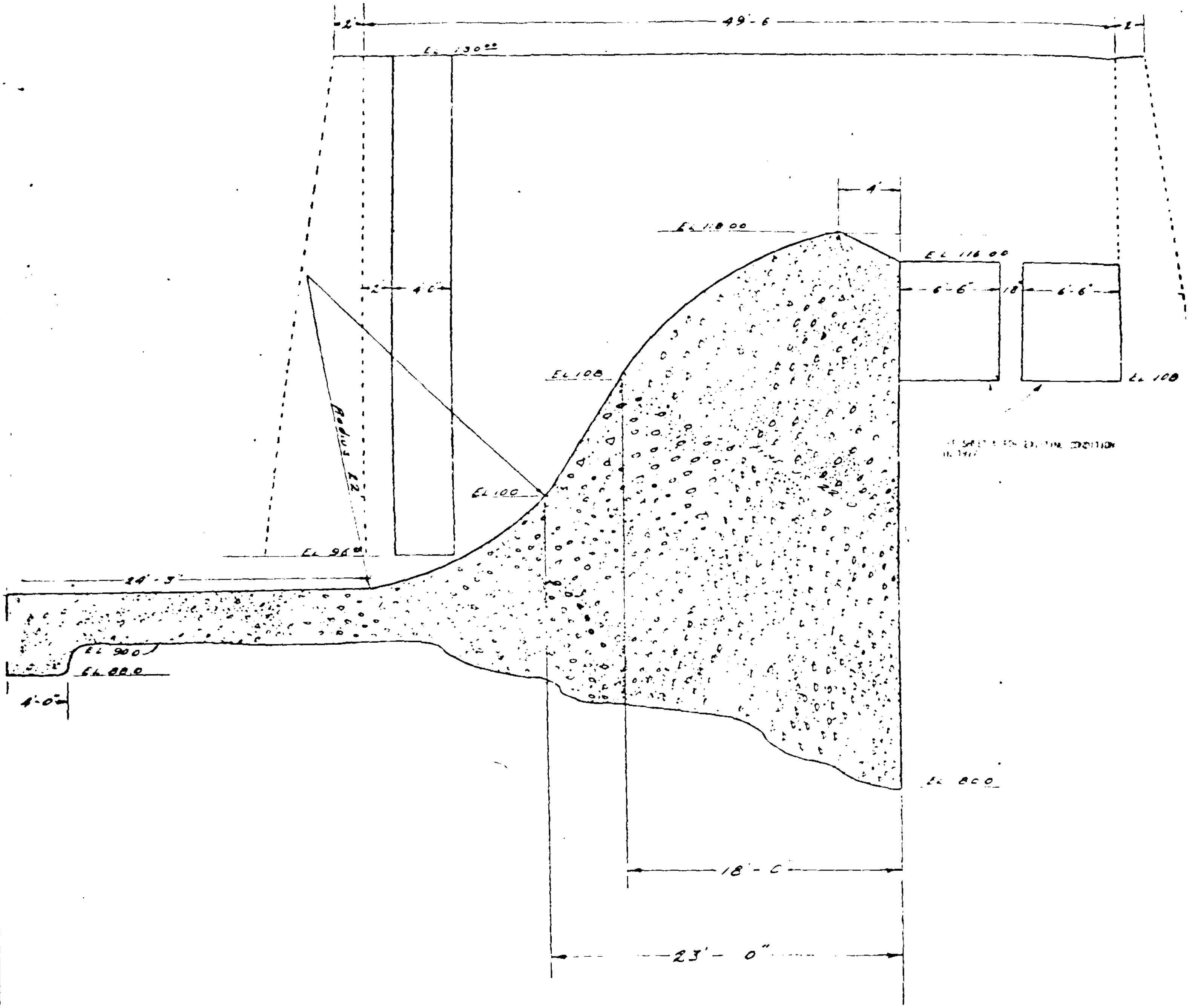
APPENDIX B


Top Of Creek Bank
Top Of Dam Elev 119.0
Rock Layer
Flow
Power Plant
Pine Trees
Pine Trees
Elevation Of Top Of Intake Channel Walls 128.0
2 Transformer Poles
4 Transformer Poles

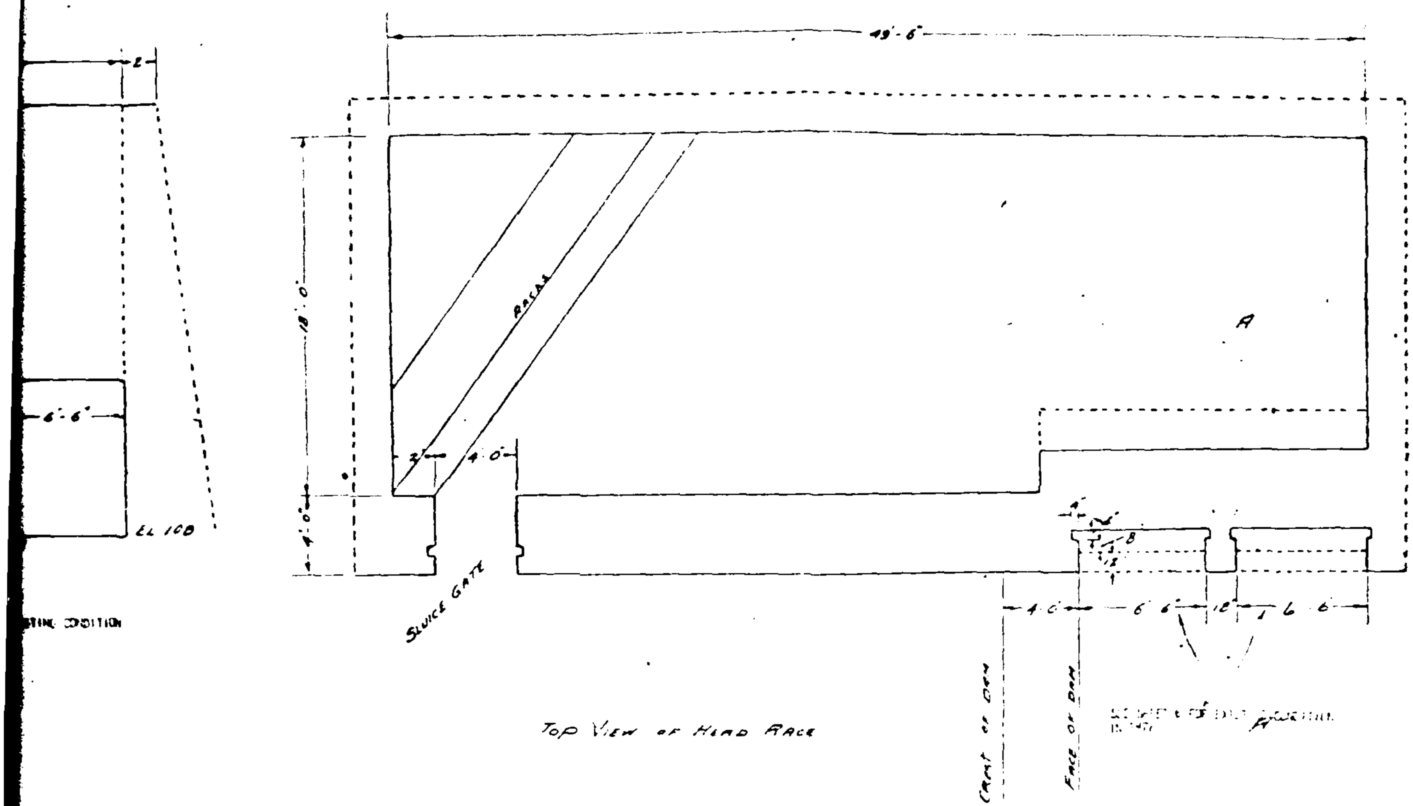


Springville, N.Y.
March 15, 1977

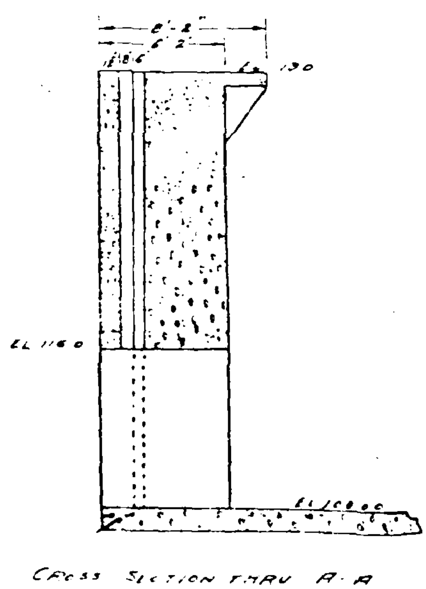
File 8-10-D Sheet 2 of 25



TYPICAL CROSS SECTION OF DAM
SHOWING INTAKE AS PART OF ABUTMENT



TOP VIEW OF HEAD RACE

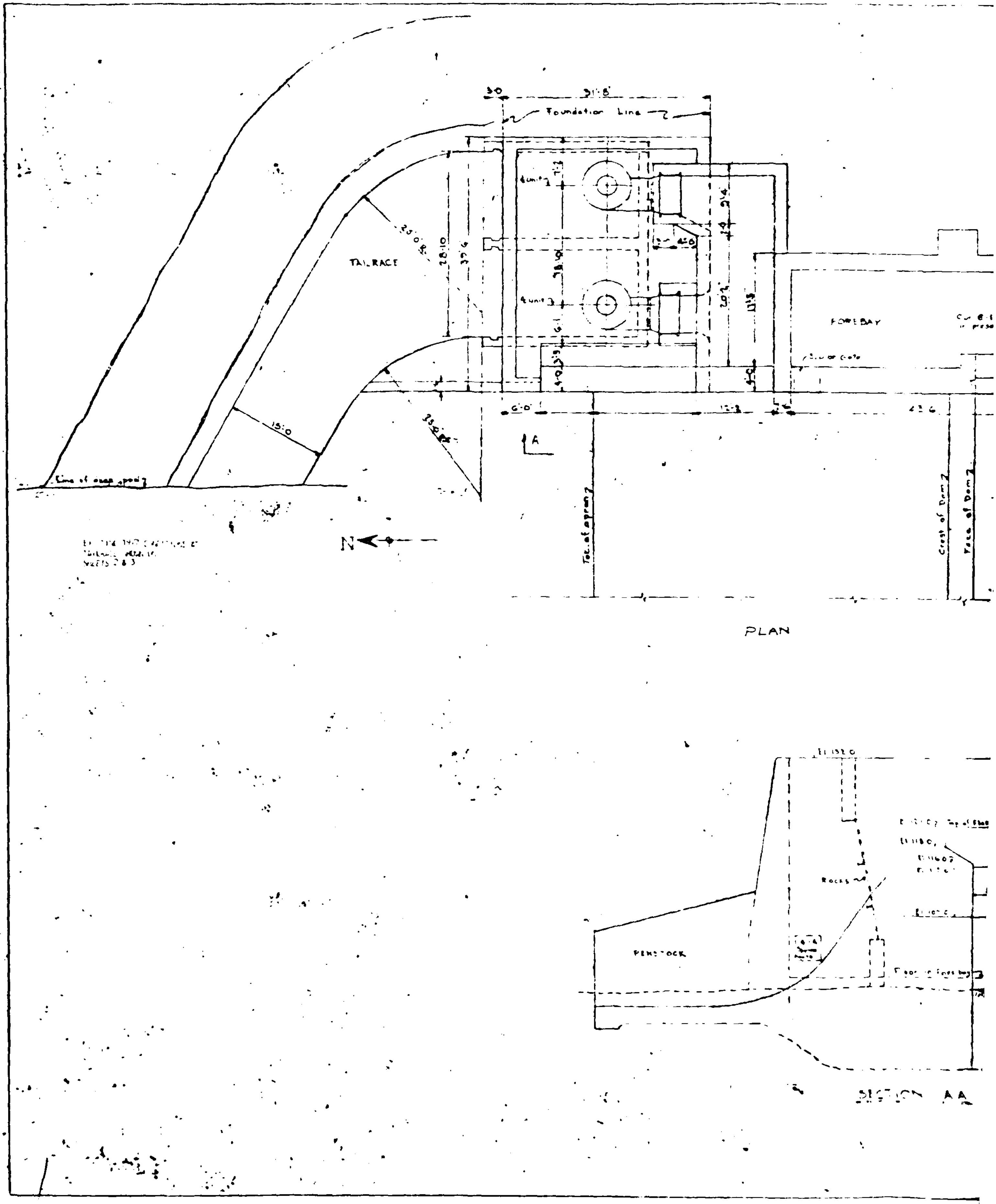


CROSS SECTION THRU A-A

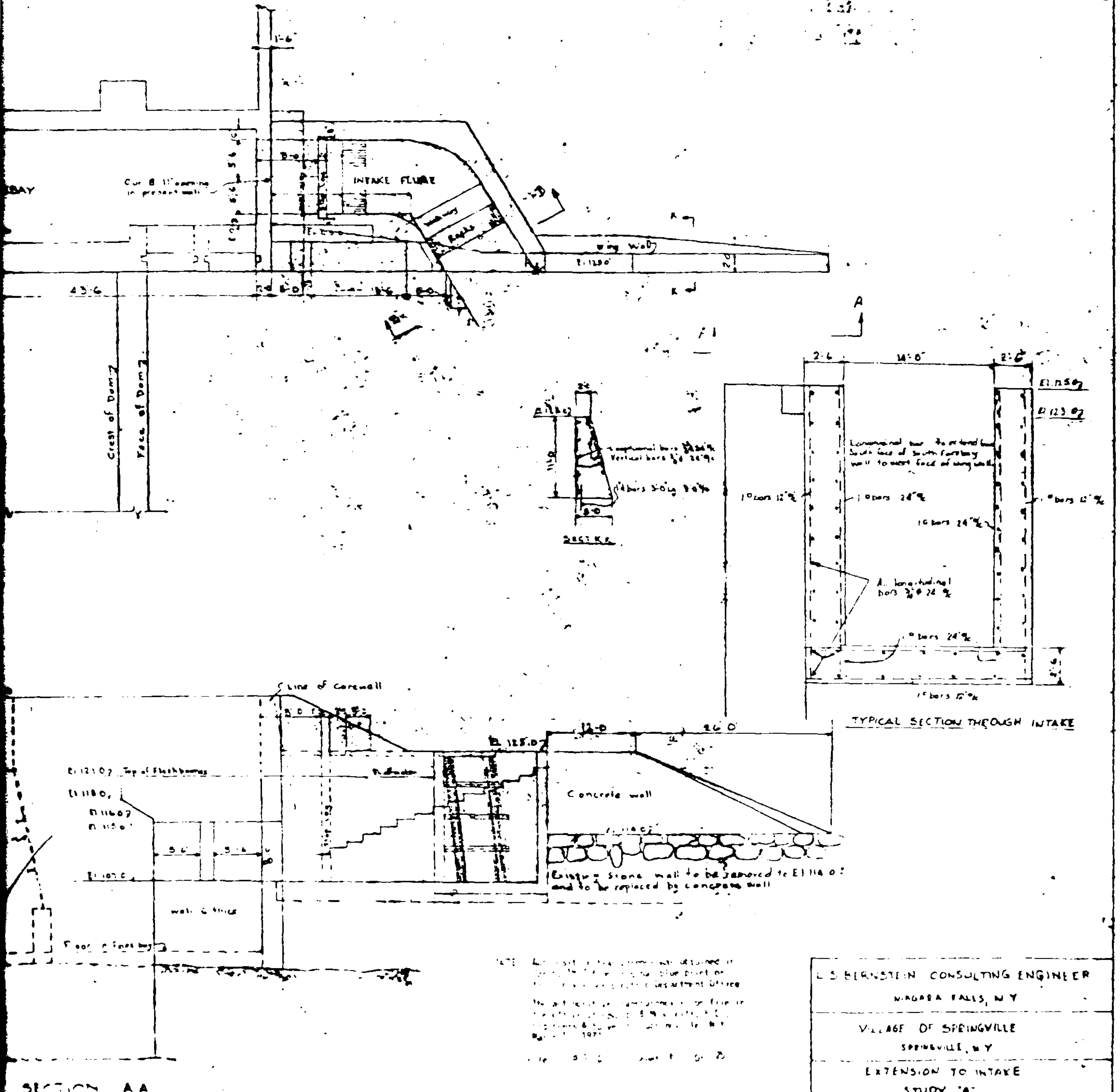
SPRINGVILLE DAM
SPRINGVILLE, N.Y.
SHEET 2

H. L. BOTSFORD ENGINEER

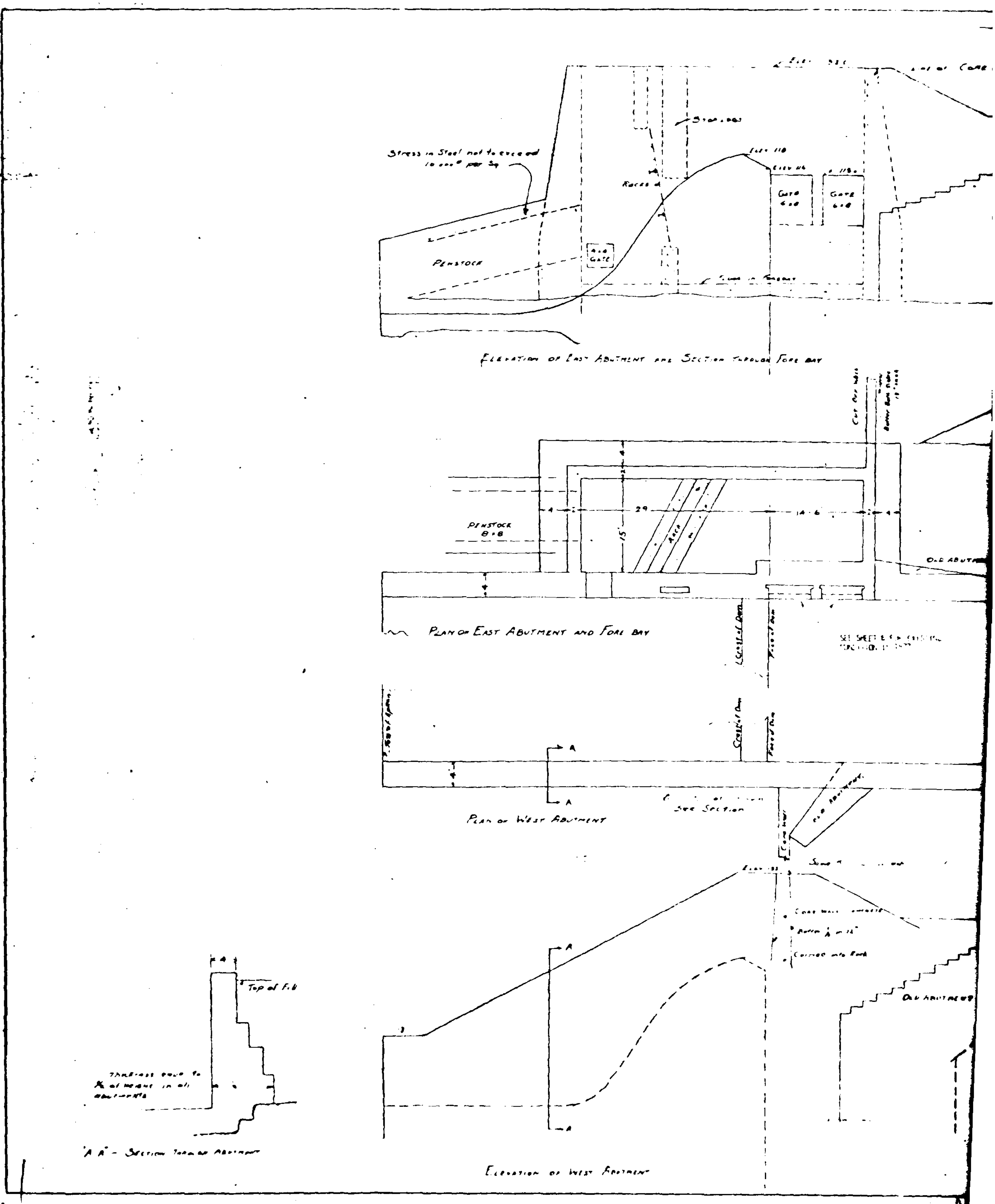
B-3



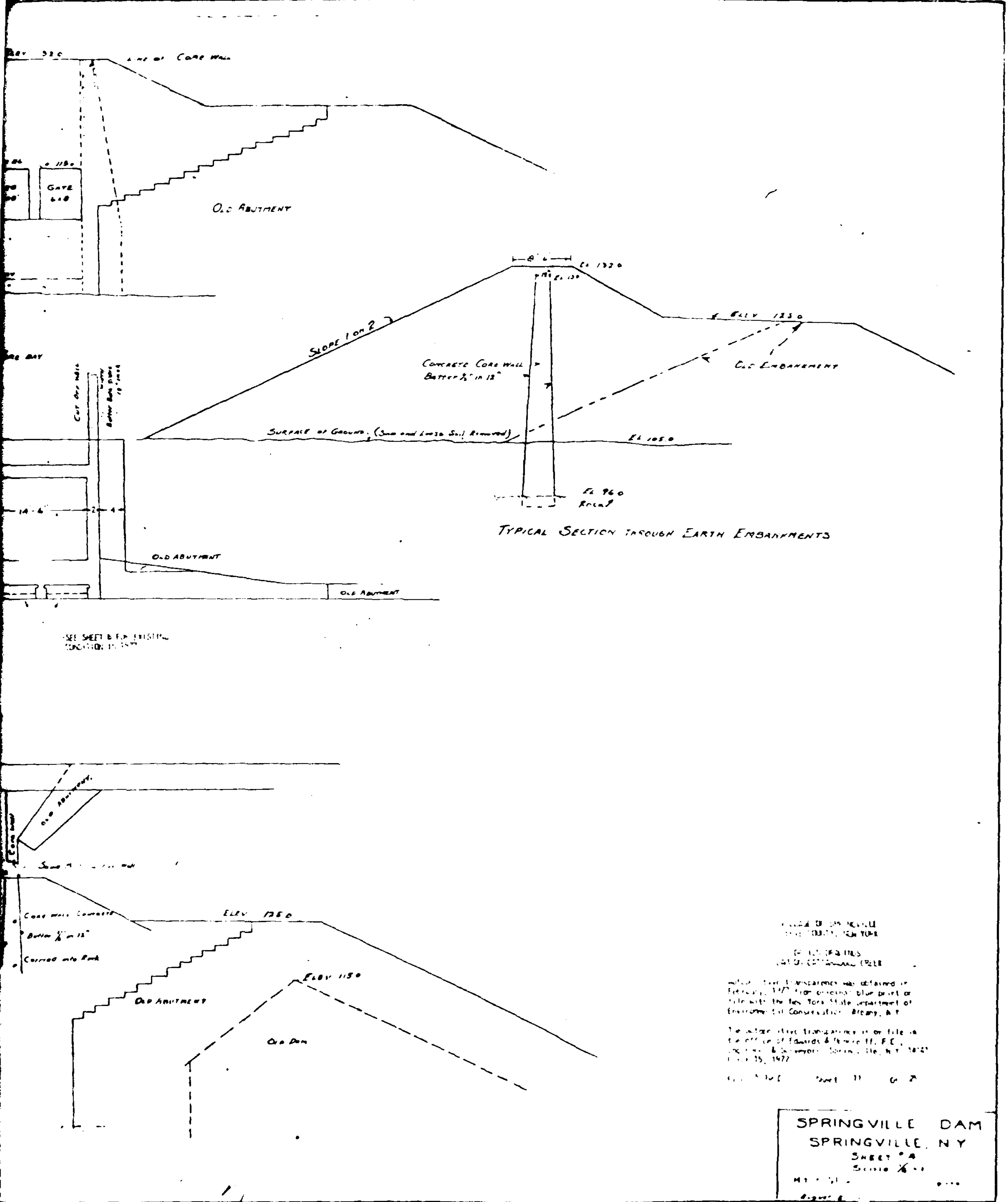
3-0
31'-8"
Foundation Line
TAILRACE
FOREBAY
15'-0
6'-0"
N
Toe of apron
Crest of Dam
Face of Dam
PLAN
PENSTOCK
Rocks
Floor of Forebay
SECTION A-A

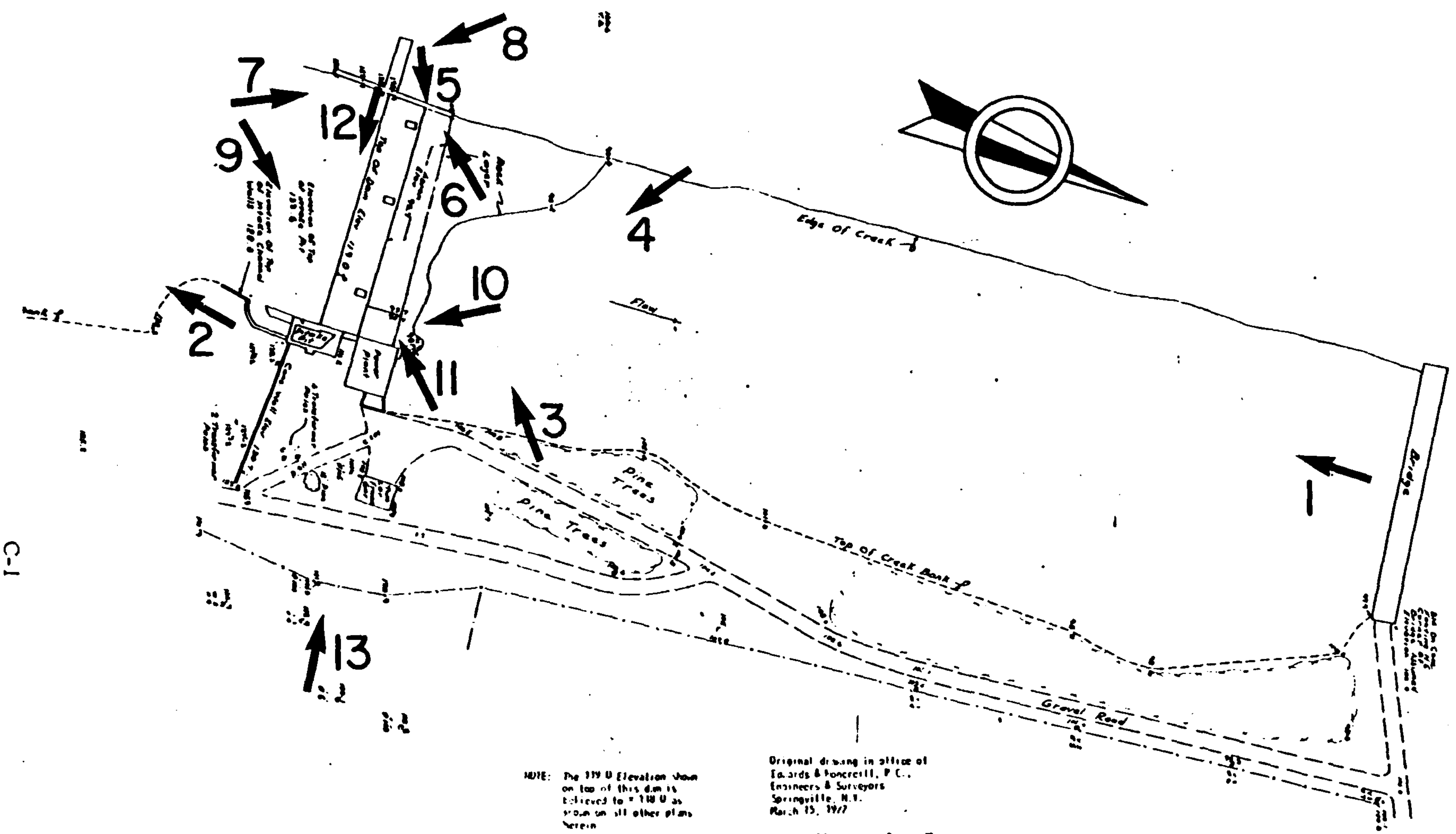


L. S. BERNSTEIN CONSULTING ENGINEER
NIAGARA FALLS, N.Y.
VILLAGE OF SPRINGVILLE
SPRINGVILLE, N.Y.
EXTENSION TO INTAKE
STUDY "A"
NO. 101



Stress in Steel not to exceed 16 000# per Sq
Stop logs
Penstock
Gate
Gate 6x8
Gate 6x8
Elev 118
Elevation of East Abutment and Section through Fore Bay
Penstock 8x8
29
14-6
15'
Plan of East Abutment and Fore Bay
Old Abutment
Plan of West Abutment
See Section
Old Abutment
Top of Fill
Thickness equal to ¾ of height in all abutments
"A A" - Section through Abutment
Elevation of West Abutment


Line of Core Wall
Gate 6x8
Old Abutment
8'6"
El. 132.0
Slope 1 on 2
Concrete Core Wall
Batter ½" in 12"
Elev 125.0
Old Embankment
Surface of Ground (Sod and Loose Soil Removed)
El. 105.0
El. 96.0
Rock
Typical Section through Earth Embankments
Cut Off Wall
14-6"
Old Abutment
Core Wall Concrete
Batter ½" in 12"
Carried into Rock
Elev 125.0
Elev 115.0
Old Dam
SPRINGVILLE DAM
SPRINGVILLE, N.Y.
Sheet #4



NOTE: The 119.0 Elevation shown on top of this dam is believed to = 118.0 as shown on all other plans herein

Original drawing in office of Edwards & Koncrettl, P.C., Engineers & Surveyors Springville, N.Y. March 15, 1977

File 0-10-0 Sheet 2 of 25

SPRINGVILLE DAM

NY00704

PHOTO ORIENTATION PLAN

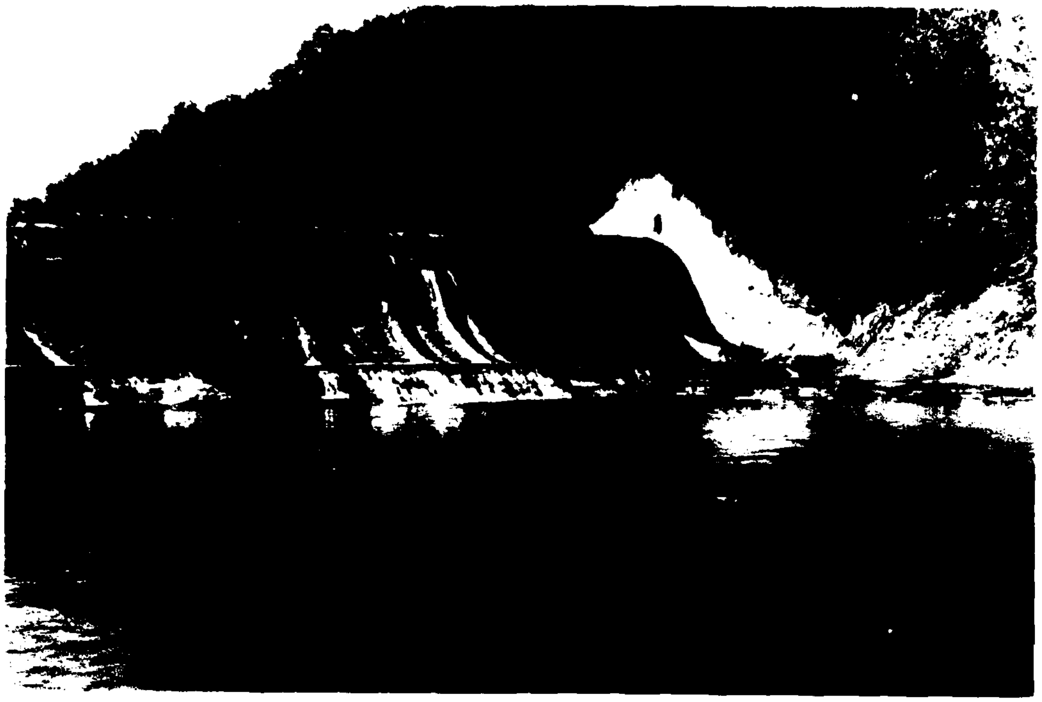
ERDMAN, ANTHONY, ASSOCIATES CONSULTING ENGINEERS & PLANNERS	DATE MAY 1981	

APPENDIX C

PHOTOGRAPHS

1. Downstream Channel

2. Upstream impoundment



3. Downstream face of dam and west abutment

4. Downstream face of dam and powerhouse

5. West face of west abutment. Note spalled concrete.

6. East face of west abutment. Note spalled concrete.

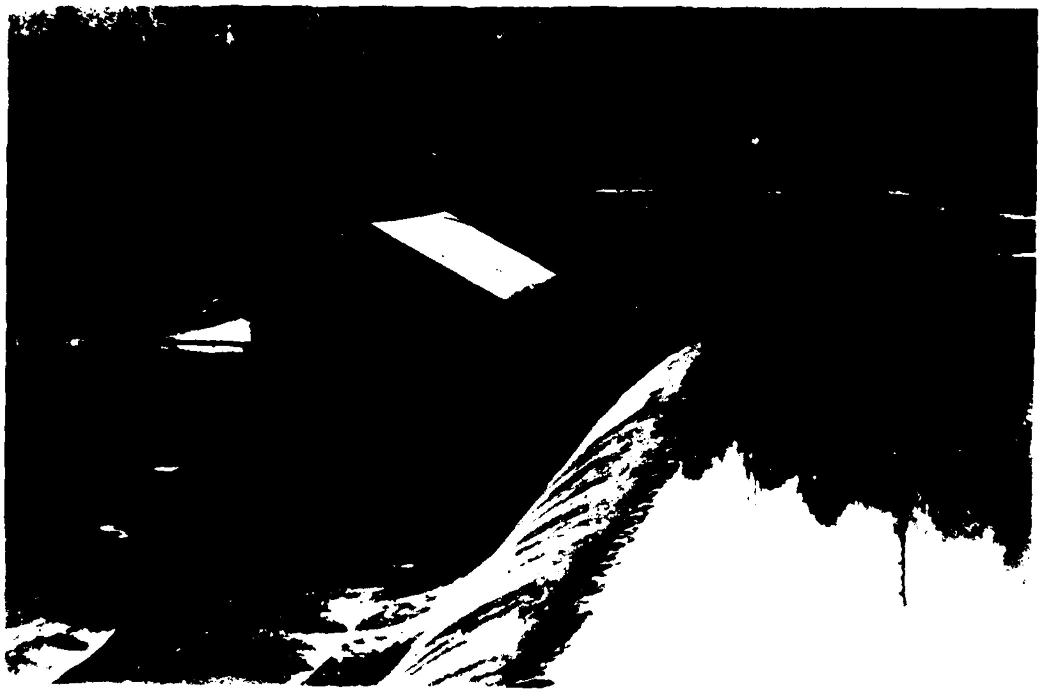
7. East face of west abutment. Note spalled concrete.

8. West wall beyond west abutment

9. Powerhouse intake structure

10. West face of inlet structure. Note cracked concrete.

11. Rock erosion under downstream apron



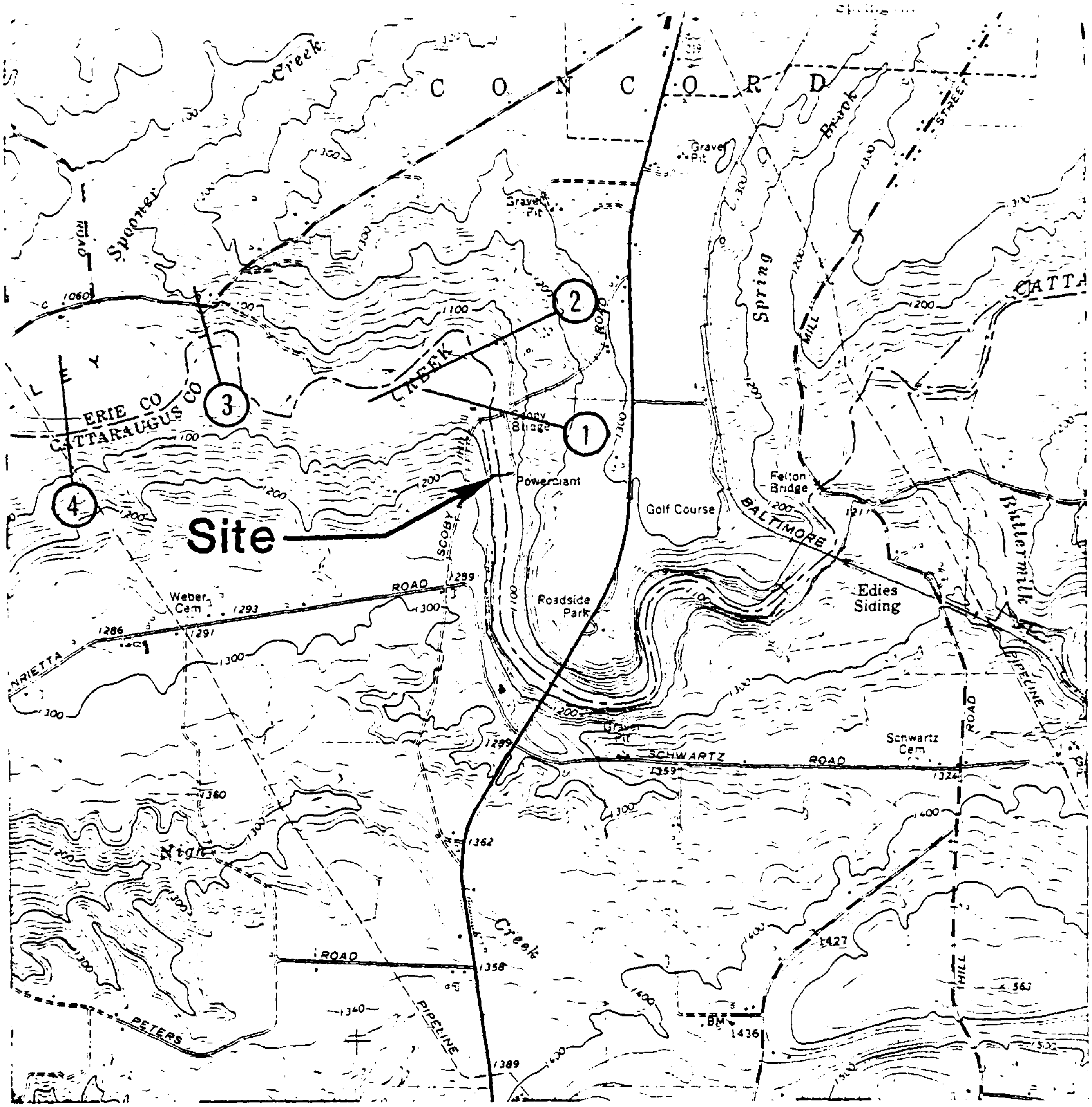
12. Powerhouse

13. Overview

APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS

APPENDIX D



Springville Dam

CROSS SECTION LOCATION PLAN

(Sheet 1 of 3)

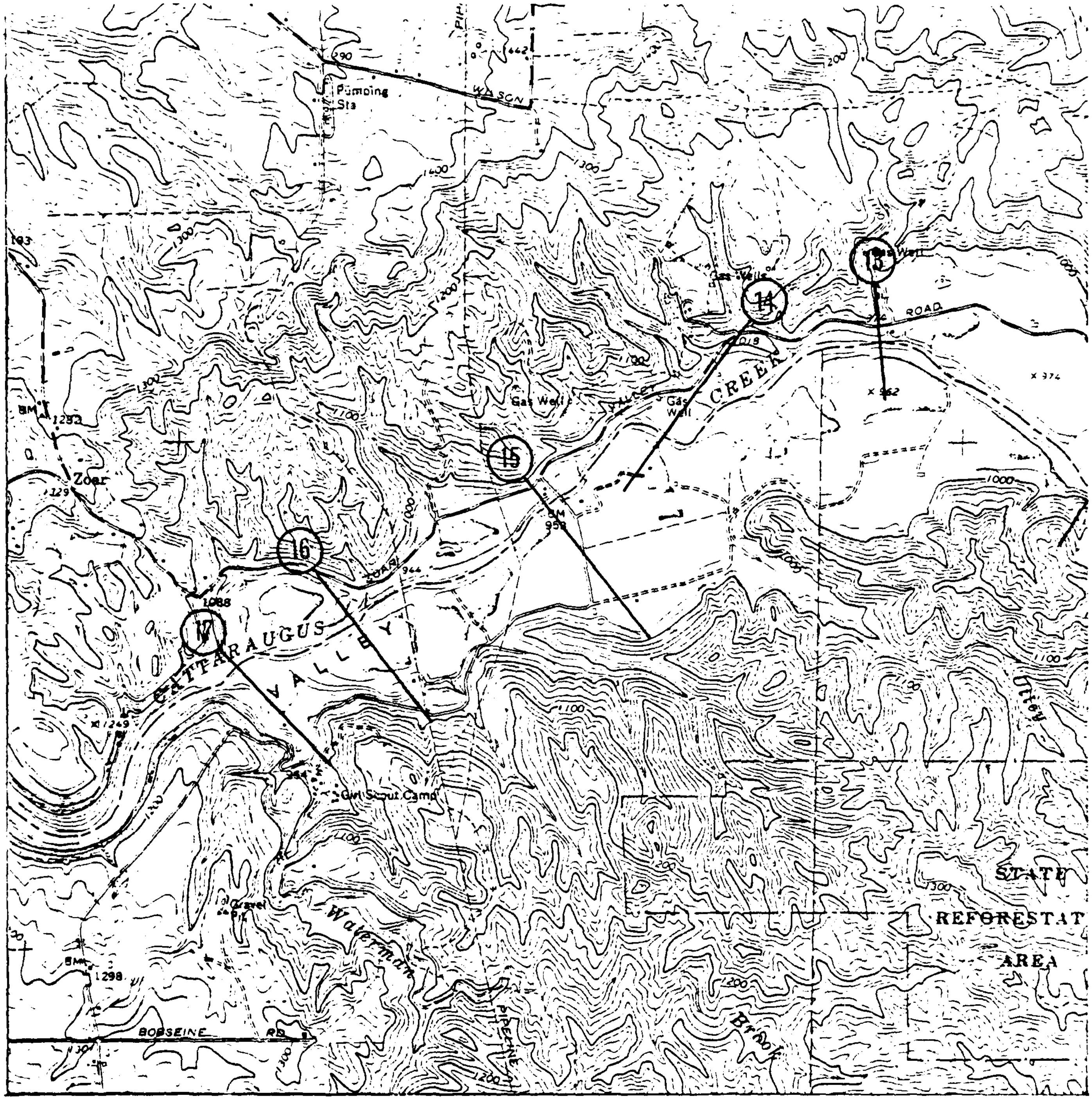
Scale: 1" = 2000'

Springville Dam

CROSS SECTION LOCATION PLAN

(Sheet 2 of 3)

Scale: 1"=2000'



Springville Dam

CROSS SECTION LOCATION PLAN

(Sheet 3 of 3)

Scale: 1"=2000'

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF      DAM NY 704
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFTEY OF SPRINGVILLE DAM
A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
B    100       1       0                                 0      -1       4
B1     5
J      1       6       1
J1   0.2     0.4     0.5     0.6     0.8     1.0
K      0       1                       0       0       1       0
K1     COMPUTE HYDROGRAPHS FOR SUB-AREA 1
M      1       1    79.1             280       0                       1
P      0    22.2      76      86      96     106
T                                                      1.      .1              0
W   8.89     .63
X     2.     -.1      2.
K      1       B                       0       0       1       0
K1      ROUTE THE HYDROGRAPH FROM SUB-AREA 1 TO POINT B BY MUSKINGUM METHOD
Y                              0       1
Y1     1       0       2    0.74     0.2       0      -1
K      0       2                       0       0       1       0
K1     COMPUTE HYDROGRAPH FOR SUB-AREA 2
M      1       1    71.1             280       0                       1
P      0    22.2      76      86      96     106
T                                                      1.     0.1              0
W   9.03     .63
X     2.     -.1      2.
K      2       B                       0       0       1       0
K1      COMBINE HYDROGRAPHS FROM SUB-AREAS 1 AND 2 AT POINT B
K      0       3                       0       0       1       0
K1     COMPUTE HYDROGRAPH FOR SUB-AREA 3
M      1       1    29.5             280       0                       1
P      0    22.2      76      86      96     106
T                                                      1.      .1              0
W   4.84     .63
X     2.     -.1      2.
K      2       B                       0       0       1       0
K1      COMBINE-HYDROGRAPHS FROM SUB-AREAS 1-2 AND 3 AT POINT B
K      1       C                       0       0       1       0
K1      ROUTE THE COMBINED HYDROGRAPH FROM POINT B TO C BY MUSKINGUM METHOD
Y                              0       1
Y1     1       0       3    2.35     0.2       0      -1
K      0       4                                       1
K1     COMPUTE HYDROGRAPH FOR SUB-AREA 4
M      1       1   100.3             280       0                       1
P      0    22.2      76      86      96     106
T                                                      1.      .1              0
W   6.94     .63
X     2.     -.1      2.
K      2       C                                       1
K1      COMBINE ALL HYDROGRAPHS AT POINT C - INFLOW TO RESERVOIR
K      1 OUTFLOW                                       1
K1      CALCULATION OF OUTFLOW HYDROGRAPH FROM RESERVOIR
Y                              1       1
Y1     1                                       -1093.7      -1
Y41093.7    1095    1097  1097.7    1100    1102  1103.8  1105.6  1106.1  1107.4
Y41108.2  1110.6    1113    1115    1117    1120    1122  1123.7    1124    1125
Y5     0    1071    4331    5780   11425   17277   23192   29661   31550   36639
Y5 39895   50199   61263   71328   81264   97453  108778  118725  120511  126526
```

```
$A    13      22      42      47     285
$E1090.7 1093.7  1097.7    1100    1120
$$1093.7
$D1103.8
$L  17.8   136.3   205.8   209.8   231.3   245.6
$V1103.8  1105.6  1106.1  1107.4  1108.2  1110.6
K       1       1                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 0-1
Y                                       1       1
Y1      1
Y6    0.1    0.45     0.1    1055    1100    1000  0.0111
Y7      0    1070     430    1067     440    1055     640    1055     650    1067
Y7    900    1080    1100    1100    1101    1100
K       1       2                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 1-2
Y                                       1       1
Y1      1
Y6    0.1    0.45     0.1    1049    1100    1000   0.006
Y7      0    1060     900    1060    1000    1059    1010    1049    1210    1049
Y7   1220    1059    1300    1060    1700    1100
K       1       3                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 2-3
Y                                       1       1
Y1      1
Y6    0.1   0.045     0.1    1038    1100    5100  0.0022
Y7      0    1050     590    1048     600    1038     800    1038     810    1048
Y7    900    1060    1000    1080    1100    1100
K       1       4                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 3-4
Y                                       1       1
Y1      1
Y6   0.07   0.035    0.07    1032    1080    2720  0.0022
Y7      0    1080     300    1040     314    1038     320    1032     526    1032
Y7    530    1038     620    1040    1000    1048
K       1       5                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 4-5
Y                                       1       1
Y1      1
Y6   0.07   0.035    0.07    1025    1100    4200  0.0017
Y7      0    1037     589    1031     595    1025     795    1025     801    1031
Y7   1020    1040    1100    1060    1400    1100
K       1       6                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 5-6
Y                                       1       1
Y1      1
Y6   0.06    0.04    0.06    1019    1100    3800  0.0016
Y7      0    1100     175    1080     260    1040     359    1025     365    1019
Y7    540    1019     546    1025    1150    1040
K       1       7                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 6-7
Y                                       1       1
Y1      1
Y6   0.06    0.04    0.06    1017    1060     990  0.0022
Y7      0    1038     500    1023     574    1023     580    1017     755    1017
Y7    761    1023    1200    1040    1300    1060
K       1       8                                        1
K1     CHANNEL ROUTING -MOD PULS- REACH 7-8
```

```
Y                                  1        1
Y1     1
Y6  0.06     0.04     0.06     1014     1040     1000    0.002
Y7     0     1018      507     1018      510     1015      685     1015      688     1018
Y7   975     1020     1400     1030     1800     1040
K      1        9                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 8-9
Y                                  1        1
Y1     1
Y6  0.06     0.04     0.06     1009     1100     2700   0.0022
Y7     0     1100      310     1020      342     1017      350     1009      525     1009
Y7   533     1017     1400     1020     1800     1100
K      1       10                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 9-10
Y                                  1        1
Y1     1
Y6  0.06     0.04     0.06      992     1100     7300   0.0023
Y7     0     1100      150     1020      272     1000      280      992      470      992
Y7   478     1000      525     1020     1200     1100
K      1       11                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 10-11
Y                                  1        1
Y      1
Y6  0.06     0.04     0.06      980     1100     4840   0.0017
Y7     0      997      442      988      450      980      625      980      633      988
Y7   675     1000     1000     1100     1001     1100
K      1       12                                                1
K1    CHANNSEL ROUTING -MOD PULS- REACH 11-12
Y                                  1        1
Y1     1
Y6  0.06     0.04     0.06      960     1060     7900   0.0025
Y7     0     1060      150      980      190      970      200      960      375      960
Y7   385      970      600      980      700     1000
K      1       13                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 12-13
Y                                  1        1
Y1     1
Y6  0.06     0.04     0.06      948      974     3800   0.0032
Y7     0      962      600      960      672      956      680      948      855      948
Y7   863      956      900      960     1100      974
K      1       14                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 13-14
Y                                  1        1
Y1     1
Y6  0.06     0.04     0.06      942     1000     3300   0.0018
Y7     0      946      846      946      850      942     1025      942     1029      946
Y7  1700      960     2100     1000     2101     1000
K      1       15                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 14-15
Y                                  1        1
Y1     1
Y6  0.06     0.04    0.045      937     1200     3000   0.0017
Y7     0     1000      170      960     2357      945     2365      937     2540      937
Y7  2548      945     2600      960     2900     1000
K      1       16                                                1
K1    CHANNEL ROUTING -MOD PULS- REACH 15-16
Y                                  1        1
```

```
A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF     DAM NY 704

Y1       1
Y6    0.06      0.04     0.045       931      1000      3300  0.0018       940      1710       931
Y7       0      1000       500       940      1300       941    1701
Y7    1885       931      1894       940      2700       980
K        1        17                             1
K1      CHANNEL ROUTING -MOD PULS- REACH 16-17
Y                                    1           1
Y1       1
Y6    0.06      0.04     0.045       928       980      1700  0.0018       928      1982       928
Y7       0       980      1200       940      1800       935    1807
Y7    1989       935      2200       940      2300       980
K       99
A
```

```
OK, SEG #HEC1DB
ENTER PROJECT NUMBER
80166-00.10
INPUT FILE ? NY704
1********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
 ********************************
1                               PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS
                                        RUNOFF HYDROGRAPH AT            1
                                        ROUTE HYDROGRAPH TO             B
                                        RUNOFF HYDROGRAPH AT            2
                                        COMBINE  2 HYDROGRAPHS AT       B
                                        RUNOFF HYDROGRAPH AT            3
                                        COMBINE  2 HYDROGRAPHS AT       B
                                        ROUTE HYDROGRAPH TO             C
                                        RUNOFF HYDROGRAPH AT            4
                                        COMBINE  2 HYDROGRAPHS AT       C
                                        ROUTE HYDROGRAPH TO        UTFLOW
                                        ROUTE HYDROGRAPH TO             1
                                        ROUTE HYDROGRAPH TO             2
                                        ROUTE HYDROGRAPH TO             3
                                        ROUTE HYDROGRAPH TO             4
                                        ROUTE HYDROGRAPH TO             5
                                        ROUTE HYDROGRAPH TO             6
                                        ROUTE HYDROGRAPH TO             7
                                        ROUTE HYDROGRAPH TO             8
                                        ROUTE HYDROGRAPH TO             9
                                        ROUTE HYDROGRAPH TO            10
                                        ROUTE HYDROGRAPH TO            11
                                        ROUTE HYDROGRAPH TO            12
                                        ROUTE HYDROGRAPH TO            13
                                        ROUTE HYDROGRAPH TO            14
                                        ROUTE HYDROGRAPH TO            15
                                        ROUTE HYDROGRAPH TO            16
                                        ROUTE HYDROGRAPH TO            17
                                        END OF NETWORK

1********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
 ********************************

 RUN  DATE: 8/11/
      TIME: 4:04 PM

                     ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF      DAM NY 704
                     HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFTEY OF SPRINGVILLE DAM
                     RATIOS OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM

                                           JOB SPECIFICATION
              NQ      NHR     NMIN     IDAY      IHR     IMIN   METRC     IPLT     IPRT    NSTAN
             103        1        0        9        0        0       0       -1        4        0
                                      JOPER      NWT    LROPT   TRACE
```

```
                              5       0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                             NPLAN= 1 NRTIO= 6 LRTIO= 1
                RTIOS=   0.20   0.40   0.50   0.60   0.80   1.00


     **********      **********      **********      **********      **********

                              SUB-AREA RUNOFF COMPUTATION

          COMPUTE HYDROGRAPHS FOR SUB-AREA 1
                   ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                       1       0       0       0       0       0       1       0       0

                                        HYDROGRAPH DATA
            IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                1       1   79.10    0.00  280.00    0.00   0.000       0       1       0

                                          PRECIP DATA
                      SPFE     PMS      R6     R12     R24     R48     R72     R96
                      0.00   22.20   76.00   86.00   96.00  106.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.889

                                           LOSS DATA
       LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
           0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                      UNIT HYDROGRAPH DATA
                                  TP=  8.89     CP=0.63     NTA=  0

                                         RECESSION DATA
                           STRTQ=     2.00    QRCSN=   -0.10    RTIOR= 2.00

          UNIT HYDROGRAPH 49 END-OF-PERIOD ORDINATES, LAG=   8.90 HOURS, CP= 0.63  VOL= 1.00
        133.      495.      997.     1571.     2187.     2779.     3248.     3553.     3696.     3619.
       3319.     2936.     2597.     2297.     2032.     1797.     1590.     1406.     1244.     1100.
        973.      861.      761.      674.      596.      527.      466.      412.      365.      323.
        285.      252.      223.      197.      175.      155.      137.      121.      107.       55.
         84.       74.       65.       58.       51.       45.       40.       35.       31.

   0                                  END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                     SUM  20.92  17.12   3.80  899064.
                                                                        ( 531.)( 435.)(  97.)(25458.63)


     **********      **********      **********      **********      **********

                                       HYDROGRAPH ROUTING

                ROUTE THE HYDROGRAPH FROM SUB-AREA 1 TO POINT P BY MUSKINGUM METHOD
                   ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
```

```
                              8         1         0         0         0         0         1         0         0
                                                      ROUTING DATA
                     QLOSS     CLOSS      AVG      IRES    ISAME      IOPT      IPMP                LSTR
                       0.0     0.000     0.00         0        1         0         0                   0

                               NSTPS     NSTDL      LAG     AMSKK        X       TSK     STORA    ISPRAT
                                   1         0        2     0.740    0.200     0.000       -1.         0


          **********          **********          **********          **********          **********

                                                SUB-AREA RUNOFF COMPUTATION

                  COMPUTE HYDROGRAPH FOR SUB-AREA 2
                               ISTAQ     ICOMP     IECON     ITAPE      JPLT      JPRT     INAME    ISTAGE     IAUTO
                                   2         0         0         0         0         0         1         0         0

                                                         HYDROGRAPH DATA
                     IHYDG      IUHG     TAREA      SNAP     TRSDA     TRSPC     RATIO     ISNOW     ISAME     LOCAL
                         1         1     71.10      0.00    280.00      0.00     0.000         0         1         0

                                                           PRECIP DATA
                                SPFE       PMS        R6       R12       R24       R48       R72       R96
                                0.00     22.20     76.00     86.00     96.00    106.00      0.00      0.00
  TRSPC COMPUTED BY THE PROGRAM IS 0.889

                                                            LOSS DATA
                 LROPT     STRKR     DLTKR     RTIOL     FRAIN     STRKS     RTIOK     STRTL     CNSTL     ALSMX     RTIMP
                     0      0.00      0.00      1.00      0.00      0.00      1.00      1.00      0.10      0.00      0.00

                                                        UNIT HYDROGRAPH DATA
                                                TP=  9.03     CP=0.63     NTA=  0

                                                          RECESSION DATA
                                    STRTQ=     2.00     QRCSN=    -0.10     RTIOR= 2.00

                      UNIT HYDROGRAPH 49 END-OF-PERIOD ORDINATES, LAG=   9.05 HOURS, CP= 0.62  VOL= 1.00
                     116.      432.      870.     1372.     1910.     2434.     2857.     3138.     3275.     3243.
                    3000.     2658.     2354.     2084.     1846.     1634.     1447.     1281.     1135.     1005.
                     890.      788.      698.      618.      547.      484.      429.      380.      336.      298.
                     264.      234.      207.      183.      162.      144.      127.      113.      100.       88.
                      78.       69.       61.       54.       48.       43.       38.       33.       30.

             0                                            END-OF-PERIOD FLOW
          MO.DA  HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q       MO.DA  HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q
                                                                                        SUM  20.92   17.12    3.80   807383.
                                                                                           ( 531.)( 435.)(  97.)(22862.52)


          **********          **********          **********          **********          **********

                                                  COMBINE HYDROGRAPHS

                         COMBINE HYDROGRAPHS FROM SUB-AREAS 1 AND 2 AT POINT B
```

```
                         ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAPE  ISTAGE   IAUTO
                             8       2       0       0       0       0       1       0       0

        **********     **********     **********     **********     **********

                                  SUB-AREA RUNOFF COMPUTATION

                  COMPUTE HYDROGRAPH FOR SUB-AREA 3
                         ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAPE  ISTAGE   IAUTO
                             3       0       0       0       0       0       1       0       0

                                       HYDROGRAPH DATA
                 IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                     1       1   29.50    0.00  280.00    0.00   0.000       0       1       0

                                        PRECIP DATA
                     SPFE     PMS      R6     R12     R24     R48     R72     R96
                     0.00   22.20   76.00   86.00   96.00  106.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.889

                                         LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                    UNIT HYDROGRAPH DATA
                                TP=  4.84     CP=0.63     NTA=  0

                                       RECESSION DATA
                         STRTQ=     2.00     QRCSN=    -0.10     RTIOR= 2.00

          UNIT HYDROGRAPH 26 END-OF-PERIOD ORDINATES, LAG=   4.83 HOURS, CP= 0.64  VOL= 1.00
       213.      770.     1498.     2144.     2486.     2391.     1987.     1573.     1245.      585.
       780.      617.      488.      386.      306.      242.      191.      152.      120.       95.
        75.       59.       47.       37.       29.       23.

     0                                 END-OF-PERIOD FLOW
MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                           SUM  20.92  17.12   3.80   356545.
                                                                              ( 531.)( 435.)(  97.)(10096.22)

        **********     **********     **********     **********     **********

                                     COMBINE HYDROGRAPHS

                   COMBINE HYDROGRAPHS FROM SUB-AREAS 1-2 AND 3 AT POINT B
                         ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAPE  ISTAGE   IAUTO
                             8       2       0       0       0       0       1       0       0

        **********     **********     **********     **********     **********
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                                            HYDROGRAPH ROUTING

                         ROUTE THE COMPINED HYDROGRAPH FROM POINT B TO C BY MUSKINGUM METHOD
                                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                        C       1       0       0       0       0       1       0       0
                                                          ROUTING DATA
                          QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                            0.0   0.000    0.00       0       1       0       0               0

                                    NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                        1       0       3   2.350   0.200   0.000     -1.       0


          **********          **********          **********          **********          **********

                                          SUB-AREA RUNOFF COMPUTATION

                       COMPUTE HYDROGRAPH FOR SUB-AREA 4
                                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                        4       0       0       0       0       0       1       0       0

                                                       HYDROGRAPH DATA
                         IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                             1       1  100.30    0.00  280.00    0.00   0.000       0       1       0

                                                         PRECIP DATA
                                   SPFE     PMS      R6     R12     R24     R48     R72     R96
                                   0.00   22.20   76.00   86.00   96.00  106.00    0.00    0.00
 TRSPC COMPUTED BY THE PROGRAM IS 0.889

                                                          LOSS DATA
                    LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                        0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                                     UNIT HYDROGRAPH DATA
                                                TP=  6.94     CP=0.63    NTA=  0

                                                       RECESSION DATA
                                      STRTQ=     2.00    QRCSN=    -0.10    RTIOR= 2.00

                       UNIT HYDROGRAPH 38 END-OF-PERIOD ORDINATES, LAG=   6.89 HOURS, CP= 0.63   VOL= 1.00
                   312.     1148.     2287.     3560.     4755.     5606.     6012.     5872.     5223.     4447.
                  3786.     3223.     2744.     2336.     1989.     1693.     1442.     1227.     1045.      890.
                   757.      645.      549.      467.      398.      339.      288.      246.      209.      178.
                   152.      129.      110.       94.       80.       68.       58.       49.

            0                                        END-OF-PERIOD FLOW
         MO.DA  HR.MN  PERIOD    RAIN    EXCS    LOSS    COMP Q       MO.DA  HR.MN  PERIOD    RAIN    EXCS    LOSS     COMP Q

                                                                                   SUM  20.92   17.12    3.8C  1168638.
                                                                                       ( 531.)( 435.)(  97.)(33092.11)


          **********          **********          **********          **********          **********
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                                   COMBINE HYDROGRAPHS

                   COMBINE ALL HYDROGRAPHS AT POINT C - INFLOW TO RESERVOIR
                             ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                 C       2       0       0       0       0       1       0       0


             **********        **********        **********        **********        **********

                                   HYDROGRAPH ROUTING

                   CALCULATION OF OUTFLOW HYDROGRAPH FROM RESERVOIR
                             ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                            UTFLOW       1       0       0       0       0       1       0       0
                                                   ROUTING DATA
                    QLOSS    CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                      0.0    0.000    0.00       1       1       0       0               0

                             NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                 1       0       0   0.000   0.000   0.000  -1094.      -1

     STAGE      1093.70    1095.00    1097.00    1097.70    1100.00    1102.00    1103.80    1105.60    1106.10    1107.40
                1108.20    1110.60    1113.00    1115.00    1117.00    1120.00    1122.00    1123.70    1124.00    1125.00

     FLOW          0.00    1071.00    4331.00    5780.00   11425.00   17277.00   23192.00   29661.00   31550.00   36635.00
               39895.00   50199.00   61263.00   71028.00   81264.00   97453.00  108778.00  118725.00  120511.00  126526.00

  SURFACE AREA=      13.       22.       42.       47.      285.

      CAPACITY=       0.       52.      178.      280.     3265.

     ELEVATION=    1091.     1094.     1098.     1100.     1120.

                           CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                         1093.7     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                   DAM DATA
                                          TOPEL    COQD    EXPD  DAMWID
                                         1103.8     0.0     0.0      0.

     CREST LENGTH        18.      136.      206.      210.      231.      246.
     AT OR BELOW
     ELEVATION         1103.8    1105.6    1106.1    1107.4    1108.2    1110.6

  PEAK OUTFLOW IS     29621. AT TIME   51.00 HOURS

  PEAK OUTFLOW IS     59250. AT TIME   51.00 HOURS

  PEAK OUTFLOW IS     74054. AT TIME   51.00 HOURS

  PEAK OUTFLOW IS     88855. AT TIME   51.00 HOURS

  PEAK OUTFLOW IS    118449. AT TIME   51.00 HOURS

  PEAK OUTFLOW IS    148518. AT TIME   51.00 HOURS
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**********      **********      **********      **********      **********

                              HYDROGRAPH ROUTING

          CHANNEL ROUTING -MOD PULS- REACH 0-1
                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    1       1       0       0       0       0       1       0       0
                                      ROUTING DATA
       QLOSS    CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
         0.0    0.000    0.00       1       1       0       0               0

                NSTPS   NSTOL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                    1       0       0   0.000   0.000   0.000      0.       0
```

NORMAL DEPTH CHANNEL ROUTING

```
   QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
  0.1000  0.4500  0.1000  1055.0  1100.0   1000.  0.01110

   CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
        0.00 1070.00  430.00 1067.00  440.00 1055.00  640.00 1055.00  650.00 1067.00
      900.00 1080.00 1100.00 1100.00 1101.00 1100.00
```

STORAGE	0.00	10.98	22.18	33.59	45.21	57.05	78.13	116.00	157.36	201.21
	247.53	296.21	346.36	397.79	450.52	504.53	559.84	616.42	674.30	732.46
OUTFLOW	0.00	296.07	947.89	1878.94	3060.74	4477.53	6091.54	11479.78	20413.40	32131.53
	46385.52	63436.40	83351.77	105649.33	130350.17	157475.03	187046.72	219090.22	253632.81	290703.31
STAGE	1055.00	1057.37	1059.74	1062.11	1064.47	1066.84	1069.21	1071.58	1073.95	1076.32
	1078.68	1081.05	1083.42	1085.79	1088.16	1090.53	1092.89	1095.26	1097.63	1100.00
FLOW	0.00	296.07	947.89	1878.94	3060.74	4477.53	6091.54	11475.78	20413.40	32131.53
	46385.52	63436.40	83351.77	105649.33	130350.17	157475.03	187046.72	219090.22	253632.81	290703.31

MAXIMUM STAGE IS 1075.8

MAXIMUM STAGE IS 1080.5

MAXIMUM STAGE IS 1082.3

MAXIMUM STAGE IS 1084.0

MAXIMUM STAGE IS 1087.0

MAXIMUM STAGE IS 1089.7

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**********      **********      **********      **********      **********
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                                             HYDROGRAPH ROUTING

                     CHANNEL ROUTING -MOD PULS- REACH 1-2
                           ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                               2        1        0        0        0        0        1        0        0
                                                     ROUTING DATA
                   QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                     0.0    0.000     0.00        1        1        0        0                 0

                           NSTPS    NSTOL      LAG    AMSKK        X      TSK    STORA   ISPRAT
                               1        0        0    0.000    0.000    0.000       0.        0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

           QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
          0.1000   0.4500   0.1000   1049.0   1100.0    1000.  0.00600

            CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
               0.00 1060.00  900.00 1060.00 1000.00 1059.00 1010.00 1049.00 1210.00 1045.00
             1220.00 1059.00 1300.00 1060.00 1700.00 1100.00

   STORAGE          0.00      12.49      25.31      38.46      53.05     128.23     210.65     294.73     380.46     461.84
                  556.88     647.57     739.92     833.92     929.57    1026.88    1125.84    1226.45    1328.72    1432.64

   OUTFLOW          0.00     265.22     840.31    1649.25    2705.32    9711.88   24937.07   46442.61   73547.97  105870.88
               143164.44  185257.63  232026.78  283380.38  339250.13  399584.19  464344.38  533502.00  607037.00  684936.13

     STAGE       1049.00    1051.68    1054.37    1057.05    1059.74    1062.42    1065.10    1067.79    1070.47    1073.16
                 1075.84    1078.52    1081.21    1083.89    1086.58    1089.26    1091.95    1094.63    1097.31    1100.00

      FLOW          0.00     265.22     840.31    1649.25    2705.32    9711.88   24937.07   46442.61   73547.97  105870.88
               143164.44  185257.63  232026.78  283380.38  339250.13  399584.19  464344.38  533502.00  607037.00  684936.13

MAXIMUM STAGE IS    1065.7

MAXIMUM STAGE IS    1069.1

MAXIMUM STAGE IS    1070.5

MAXIMUM STAGE IS    1071.7

MAXIMUM STAGE IS    1074.1

MAXIMUM STAGE IS    1076.2


                **********         **********         **********         **********         **********

                                             HYDROGRAPH ROUTING

                     CHANNEL ROUTING -MOD PULS- REACH 2-3
                           ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
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OK, SEG #HEC1DB                                                                                    PAGE 0009

                                       3        1        0        0        0        0        1        0        0
                                                         ROUTING DATA
                              QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                                0.0    0.000     0.00        1        1        0        0                 0

                                       NSTPS    NSTDL      LAG    AMSKK        X      TSK    STORA   ISPRAT
                                           1        0        0    0.000    0.000    0.000       0.        0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

         QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
        0.1000   0.0450   0.1000   1038.0   1100.0    5100.  0.00220

         CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
             0.00 1050.00  590.00 1046.00  600.00 1038.00  800.00 1038.00  810.00 1048.00
           900.00 1060.00 1000.00 1080.00 1100.00 1100.00

  STORAGE          0.00       77.65      157.80      240.43      470.29      793.15     1125.36     1466.81     1815.35     2170.13
                2531.14     2898.38     3271.86     3651.56     4037.50     4429.67     4828.08     5232.72     5643.59     6060.69

  OUTFLOW          0.00     2229.99     7082.63    13929.94    23052.35    37952.52    57589.53    82351.28   113462.27   148673.47
              187829.91   230809.03   277512.44   327859.81   381785.00   439232.13   500154.94   564513.13   632273.25   703406.38

    STAGE       1038.00     1041.26     1044.53     1047.79     1051.05     1054.31     1057.58     1060.84     1064.10     1067.37
                1070.63     1073.89     1077.16     1080.42     1083.68     1086.94     1090.21     1093.47     1096.73     1100.00

     FLOW          0.00     2229.99     7082.63    13929.94    23052.35    37952.52    57585.53    82351.28   113462.27   148673.47
              187829.91   230809.03   277512.44   327859.81   381785.00   439232.13   500154.94   564513.13   632273.25   703406.38

MAXIMUM STAGE IS    1052.5

MAXIMUM STAGE IS    1057.8

MAXIMUM STAGE IS    1059.7

MAXIMUM STAGE IS    1061.5

MAXIMUM STAGE IS    1064.6

MAXIMUM STAGE IS    1067.3


               **********          **********          **********          **********          **********

                                                        HYDROGRAPH ROUTING

                         CHANNEL ROUTING -MOD PULS- REACH 3-4
                                       ISTAG    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                                           4        1        0        0        0        0        1        0        0
                                                         ROUTING DATA
                              QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                                0.0    0.000     0.00        1        1        0        0                 0
```

```
                                   NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                       1       0       0   0.000   0.000   0.000      0.       0


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

         QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
        0.0700  0.0350  0.0700  1032.0  1080.0   2720. 0.00220

         CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1080.00  300.00 1040.00  314.00 1038.00  320.00 1032.00  526.00 1032.00
            530.00 1038.00  620.00 1040.00 1000.00 1048.00

   STORAGE       0.00      32.83      66.32     104.39     162.18     241.87     343.48     462.80     586.16     712.52
               841.86     974.19    1109.51    1247.82    1389.12    1533.40    1680.68    1830.94    1984.19    2140.43

   OUTFLOW       0.00    1919.42    6071.69   12072.75   20271.78   31092.90   44916.45   62819.47   84379.14  109026.83
            136638.91  167127.66  200428.63  236492.59  275282.13  316768.19  360928.44  407745.56  457207.19  509303.50

     STAGE    1032.00    1034.53    1037.05    1039.58    1042.10    1044.63    1047.16    1049.68    1052.21    1054.74
              1057.26    1059.79    1062.31    1064.84    1067.37    1069.89    1072.42    1074.94    1077.47    1080.00

      FLOW       0.00    1919.42    6071.69   12072.75   20271.78   31092.90   44916.45   62819.47   84379.14  109026.83
            136638.91  167127.66  200428.63  236492.59  275282.13  316768.19  360928.44  407745.56  457207.19  509303.50

 MAXIMUM STAGE IS    1044.3

 MAXIMUM STAGE IS    1049.2

 MAXIMUM STAGE IS    1051.0

 MAXIMUM STAGE IS    1052.7

 MAXIMUM STAGE IS    1055.6

 MAXIMUM STAGE IS    1058.2


              **********          **********          **********          **********          **********

                                                  HYDROGRAPH ROUTING

                      CHANNEL ROUTING -MOD PULS- REACH 4-5
                                   ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                       5       1       0       0       0       0       1       0       0
                                                      ROUTING DATA
                           QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                             0.0   0.000    0.00       1       1       0       0               0

                                   NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                       1       0       0   0.000   0.000   0.000      0.       0
```

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0700	0.0350	0.0700	1025.0	1100.0	4200.	0.00170

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1037.00 589.00 1031.00 595.00 1025.00 795.00 1025.00 801.00 1031.00
1020.00 1040.00 1100.00 1060.00 1400.00 1100.00

STORAGE	0.00	77.62	179.10	440.12	816.63	1209.03	1607.45	2011.88	2422.31	2836.80
	3264.59	3701.64	4149.95	4609.54	5080.39	5562.51	6055.89	6560.55	7076.47	7602.65
OUTFLOW	0.00	3462.65	10273.50	23193.57	49299.20	89997.69	140320.38	199540.28	267151.88	342734.31
	425880.19	516775.88	615289.88	721329.00	834824.63	955724.50	1083991.00	1219596.25	1362522.00	1512757.50
STAGE	1025.00	1028.95	1032.89	1036.84	1040.79	1044.74	1048.68	1052.63	1056.58	1060.53
	1064.47	1068.42	1072.37	1076.31	1080.26	1084.21	1088.16	1092.10	1096.05	1100.00
FLOW	0.00	3462.65	10273.50	23193.57	49299.20	89997.69	140320.38	199540.28	267151.88	342734.31
	425880.19	516775.88	615289.88	721329.00	834824.63	955724.50	1083991.00	1219596.25	1362522.00	1512757.50

MAXIMUM STAGE IS 1037.8

MAXIMUM STAGE IS 1041.8

MAXIMUM STAGE IS 1043.2

MAXIMUM STAGE IS 1044.6

MAXIMUM STAGE IS 1047.0

MAXIMUM STAGE IS 1049.2

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING -MOD PULS- REACH 5-6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

```
        QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
       0.0600   0.0400   0.0600   1019.0   1100.0    3800.  0.00160

        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
            0.00 1100.00  175.00 1080.00  260.00 1040.00  359.00 1025.00  365.00 1015.00
          540.00 1019.00  546.00 1025.00 1150.00 1040.00

 STORAGE        0.00      66.67     148.99     299.71     524.73     823.85    1156.76    1493.03    1832.68    2175.69
             2522.08    2871.83    3224.95    3581.44    3941.30    4307.03    4686.13    5075.10    5485.95    5906.66

 OUTFLOW        0.00    2927.39    9205.21   19980.77   37291.75   63139.75  103760.33  152888.53  209899.38  274356.94
           345909.19  424310.25  509340.19  600821.25  698603.00  801334.63  910575.75 1026823.13 1150036.50 1280257.00

   STAGE     1019.00    1023.26    1027.53    1031.79    1036.05    1040.31    1044.58    1048.84    1053.10    1057.37
             1061.63    1065.89    1070.16    1074.42    1078.68    1082.94    1087.21    1091.47    1095.73    1100.00

    FLOW        0.00    2927.39    9205.21   19980.77   37291.75   63139.75  103760.33  152888.53  209899.38  274356.94
           345909.19  424310.25  509340.19  600821.25  698603.00  801334.63  910575.75 1026823.13 1150036.50 1280257.00

MAXIMUM STAGE IS    1034.2

MAXIMUM STAGE IS    1039.7

MAXIMUM STAGE IS    1041.5

MAXIMUM STAGE IS    1043.0

MAXIMUM STAGE IS    1045.9

MAXIMUM STAGE IS    1048.4


               **********          **********          **********          **********          **********

                                                  HYDROGRAPH ROUTING

                           CHANNEL ROUTING -MOD PULS- REACH 6-7
                                       ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                           7       1       0       0       0       0       1       0       0
                                                                 ROUTING DATA
                              QLOSS    CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                                0.0    0.000    0.00       1       1       0       0               0

                                       NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                           1       0       0   0.000   0.000   0.000      0.       0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

        QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
       0.0600   0.0400   0.0600   1017.0   1060.0     930.  0.00220
```

```
         CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1038.00  500.00 1023.00  574.00 1023.00  580.00 1017.00  755.00 1017.00
            761.00 1023.00 1200.00 1040.00 1300.00 1060.00

   STORAGE         0.00        8.29       16.79       27.07       44.59       68.37       98.40      134.69      177.24      221.05
                 280.21      336.46      393.28      450.62      508.49      566.89      625.82      685.28      745.26      805.78

   OUTFLOW         0.00     1189.69     3769.59     7516.78    13108.47    20901.98    31248.63    44475.40    60889.18    80781.11
              105895.39   136436.03   170769.00   208522.25   249569.50   293807.81   341152.56   391531.69   444884.44   521157.56

     STAGE      1017.00     1019.26     1021.53     1023.79     1026.05     1028.32     1030.58     1032.84     1035.10     1037.37
                1039.63     1041.89     1044.16     1046.42     1048.68     1050.94     1053.21     1055.47     1057.73     1060.00

      FLOW         0.00     1189.69     3769.59     7516.78    13108.47    20901.98    31248.63    44475.40    60889.18    80781.11
              105895.39   136436.03   170769.00   208522.25   249569.50   293807.81   341152.56   391531.69   444884.44   521157.56

 MAXIMUM STAGE IS     1030.2

 MAXIMUM STAGE IS     1034.9

 MAXIMUM STAGE IS     1036.6

 MAXIMUM STAGE IS     1038.1

 MAXIMUM STAGE IS     1040.6

 MAXIMUM STAGE IS     1042.7


            **********          **********          **********          **********          **********

                                        HYDROGRAPH ROUTING

                    CHANNEL ROUTING -MOD PULS- REACH 7-8
                               ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                                   8        1        0        0        0        0        1        0        0
                                                      ROUTING DATA
                       QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                         0.0    0.000     0.00        1        1        0        0                 0

                               NSTPS    NSTOL      LAG    AMSKK        X      TSK    STORA   ISPRAT
                                   1        0        0    0.000    0.000    0.000       0.        0


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

          QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
         0.0600   0.0400   0.0600   1014.0   1049.0    1000.  0.00200

          CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
               0.00 1018.00  507.00 1018.00  510.00 1015.00  685.00 1015.00  688.00 1018.00
             975.00 1020.00 1400.00 1030.00 1800.00 1040.00
```

STORAGE	0.00	1.48	7.05	13.94	39.11	69.63	102.30	136.79	173.11	211.26
	251.23	293.83	336.66	382.03	429.11	477.92	528.45	580.70	634.66	690.35
OUTFLOW	0.00	55.20	732.04	1842.91	3939.54	9089.27	16666.07	26143.56	37456.34	50565.07
	65464.08	82134.92	100593.78	120854.16	142894.91	166725.50	192358.06	219806.44	249086.53	280215.19
STAGE	1014.00	1015.37	1016.74	1018.11	1019.47	1020.84	1022.21	1023.58	1024.95	1026.32
	1027.68	1029.05	1030.42	1031.79	1033.16	1034.53	1035.89	1037.26	1038.63	1040.00
FLOW	0.00	55.20	732.04	1842.91	3939.54	9089.27	16666.07	26143.56	37456.34	50565.07
	65464.08	82134.92	100593.78	120854.16	142894.91	166725.50	192358.06	219806.44	249086.53	280215.19

MAXIMUM STAGE IS 1024.0

MAXIMUM STAGE IS 1027.1

MAXIMUM STAGE IS 1028.4

MAXIMUM STAGE IS 1029.6

MAXIMUM STAGE IS 1031.6

MAXIMUM STAGE IS 1033.5

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING -MOD PULS- REACH 8-9

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
9	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0600	0.0400	0.0600	1009.0	1100.0	2700.	0.00220

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1100.00 310.00 1020.00 342.00 1017.00 350.00 1009.00 525.00 1005.00
533.00 1017.00 1400.00 1020.00 1800.00 1100.00

STORAGE	0.00	53.37	132.59	440.53	779.30	1130.68	1494.67	1871.28	2260.51	2662.36
	3076.83	3503.91	3943.61	4395.93	4860.87	5338.43	5828.60	6331.39	6846.80	7374.83

```
   OUTFLOW        0.00      4141.31     13652.95     41240.64     89570.06    154526.25    234630.25    329046.81    437250.88    558896.88
             693754.75    841674.38   1002563.00   1176372.00   1363083.75   1562709.50   1775278.25   2000838.25   2239445.00   2451187.00

     STAGE     1009.00      1013.79      1018.58      1023.37      1028.16      1032.95      1037.74      1042.53      1047.31      1052.10
               1056.89      1061.68      1066.47      1071.26      1076.05      1080.84      1085.63      1090.42      1095.21      1100.00

      FLOW        0.00      4141.31     13652.95     41240.64     89570.06    154526.25    234630.25    329046.81    437250.88    558896.88
             693754.75    841674.38   1002563.00   1176372.00   1363083.75   1562709.50   1775278.25   2000838.25   2239445.00   2451187.00

 MAXIMUM STAGE IS    1021.3

 MAXIMUM STAGE IS    1025.2

 MAXIMUM STAGE IS    1026.6

 MAXIMUM STAGE IS    1028.1

 MAXIMUM STAGE IS    1030.3

 MAXIMUM STAGE IS    1032.5


            **********          **********          **********          **********          **********

                                                 HYDROGRAPH ROUTING

                         CHANNEL ROUTING -MOD PULS- REACH 9-10
                                     ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                        10       1       0       0       0       0       1       0       0
                                                          ROUTING DATA
                              QLOSS  CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                                0.0  0.000    0.00       1       1       0       0               0

                                     NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                         1       0       0   0.000   0.000   0.000      0.       0


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

          QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
         0.0600  0.0400  0.0600   992.0  1100.0   7300. 0.00230

          CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1100.00  150.00 1020.00  272.00 1000.00  280.00  992.00  470.00  992.00
            478.00 1000.00  525.00 1020.00 1200.00 1100.00

  STORAGE         0.00       186.41       389.77       636.00       927.98      1265.73      1655.01      2100.11      2601.06      3157.83
               3770.45      4438.90      5163.19      5943.31      6779.27      7671.07      8616.70      9622.17     10681.48     11796.63

  OUTFLOW         0.00      6114.27     19854.78     40583.07     68310.28    103291.42    146203.22    197654.31    257957.72    327555.94
             406926.75    496523.06    596807.75    708234.88    831250.63    966293.00   1113794.00   1274179.50   1447868.50   1635272.00

    STAGE       992.00       997.68      1003.37      1009.05      1014.74      1020.42      1026.11      1031.79      1037.47      1043.16
```

```
           1048.84    1054.53    1060.21    1065.89    1071.58    1077.26    1082.95    1088.63    1094.31    1100.00

     FLOW     0.00    6114.27   19854.78   40583.07   68310.28  103291.42  146203.22  157654.31  257957.72  327555.94
         406926.75  496523.06  596807.75  708234.88  831250.63  966293.00 1113794.00 1274179.50 1447868.50 1635272.00

 MAXIMUM STAGE IS    1006.0

 MAXIMUM STAGE IS    1012.9

 MAXIMUM STAGE IS    1015.7

 MAXIMUM STAGE IS    1018.1

 MAXIMUM STAGE IS    1022.4

 MAXIMUM STAGE IS    1026.3


           **********       **********       **********       **********       **********

                                           HYDROGRAPH ROUTING

                      CHANNEL ROUTING -MOD PULS- REACH 10-11
                               ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                  11       1       0       0       0       0       1       0       0
                                                 ROUTING DATA
                        QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                          0.0   0.000    0.00       1       1       0       0               0

                                NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                    1       0       0   0.000   0.000   0.000      0.       0


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

      QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
     0.0600  0.0400  0.0600   980.0  1100.0   4840. 0.00170

      CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
        0.00  997.00  442.00  988.00  450.00  980.00  625.00  980.00  633.00  988.00
      675.00 1090.00 1000.00 1100.00 1001.00 1100.00

  STORAGE     0.00     127.24     323.65     734.91    1213.37    1706.25    2213.53    2735.22    3271.31    3821.81
           4386.71    4966.01    5559.72    6167.83    6790.34    7427.26    8078.58    8744.31    9424.44   10118.97

  OUTFLOW     0.00    5815.22   19152.46   46360.55   93772.50  156245.00  232181.59  320877.13  421862.88  534810.88
         659485.25  795714.13  943372.88 1102371.25 1272647.00 1454159.00 1646885.25 1850815.00 2065951.25 2252305.00

    STAGE   980.00     986.32     992.63     998.95    1005.26    1011.58    1017.89    1024.21    1030.53    1036.84
           1043.16    1049.47    1055.79    1062.10    1068.42    1074.74    1081.05    1087.37    1093.68    1100.00

     FLOW     0.00    5815.22   19152.46   46360.55   93772.50  156245.00  232181.59  320877.13  421862.88  534810.88
         659485.25  795714.13  943372.88 1102371.25 1272647.00 1454159.00 1646885.25 1850815.00 2065951.25 2252305.00
```

[illegible] 995.1

[illegible] STAGE IS 1000.7

[illegible] STAGE IS 1002.6

MAXIMUM STAGE IS 1004.6

MAXIMUM STAGE IS 1007.8

MAXIMUM STAGE IS 1010.8

```
**********          **********          **********          **********          **********

                                   HYDROGRAPH ROUTING

        CHANNSEL ROUTING -MOD PULS- REACH 11-12
                  ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                     12       1       0       0       0       0       1       0       0
                                     ROUTING DATA
          QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
            0.0   0.000    0.00       1       1       0       0               0

                  NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                      1       0       0   0.000   0.000   0.000      0.       0
```

NORMAL DEPTH CHANNEL ROUTING

```
     QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
    0.0600  0.0400  0.0600   960.0  1060.0   7900. 0.00250

     CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
         0.00 1060.00  150.00  980.00  190.00  970.00  200.00  960.00  375.00  960.00
       385.00  970.00  600.00  980.00  700.00 1000.00
```

STORAGE	0.00	172.06	354.76	617.75	1006.96	1460.66	1948.90	2471.68	3026.98	3596.23
	4174.89	4762.98	5360.48	5967.39	6583.72	7209.47	7844.64	8489.22	9143.22	9806.65
OUTFLOW	0.00	5164.27	16434.64	34297.48	60661.17	97038.20	141991.16	195303.63	258270.97	331604.25
	413053.81	502362.94	599332.00	703798.50	815634.25	934731.88	1061002.25	1154370.00	1324775.00	1482161.50
STAGE	960.00	965.26	970.53	975.79	981.05	986.32	991.58	996.84	1002.10	1007.37
	1012.63	1017.89	1023.16	1028.42	1033.68	1038.95	1044.21	1049.47	1054.73	1060.00
FLOW	0.00	5164.27	16434.64	34297.48	60661.17	97038.20	141991.16	195303.63	258270.97	331604.25
	413053.81	502362.94	599332.00	703798.50	815634.25	934731.88	1061002.25	1154370.00	1324775.00	1482161.50

MAXIMUM STAGE IS 974.4

MAXIMUM STAGE IS 980.8

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MAXIMUM STAGE IS     983.0

MAXIMUM STAGE IS     985.1

MAXIMUM STAGE IS     988.8

MAXIMUM STAGE IS     992.2


          **********          **********          **********          **********          **********
                                                  HYDROGRAPH ROUTING

                        CHANNEL ROUTING -MOD PULS- REACH 12-13
                                  ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                                     13        1        0        0        0        0        1        0        0
                                                            ROUTING DATA
                           QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP              LSTR
                             0.0    0.000     0.00        1        1        0        0                 0

                                  NSTPS    NSTDL      LAG    AMSKK        X      TSK    STORA   ISPRAT
                                      1        0        0    0.000    0.000    0.000       0.        0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

         QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
        0.0600  0.0400  0.0600   948.0   974.0   3800. 0.00320

         CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00  962.00  600.00  960.00  672.00  956.00  680.00  948.00  855.00  948.00
            863.00  956.00  900.00  960.00 1100.00  974.00

  STORAGE         0.00       21.05       42.43       64.14       86.18      108.54      131.27      156.98      187.15      221.01
                296.33      406.50      520.31      636.45      754.93      875.74      998.88     1124.36     1252.17     1382.32

  OUTFLOW         0.00      620.97     1968.71     3865.01     6236.59     9038.73    12264.50    16058.63    20376.83    25145.95
              31057.53    39523.02    50121.06    62506.30    76566.23    92228.02   109440.80   128167.23   148379.34   170055.53

    STAGE       948.00      949.37      950.74      952.11      953.47      954.84      956.21      957.58      958.95      960.32
                961.68      963.05      964.42      965.79      967.16      968.53      969.89      971.26      972.63      974.00

     FLOW         0.00      620.97     1968.71     3865.01     6236.59     9038.73    12264.50    16058.63    20376.83    25145.95
              31057.53    39523.02    50121.06    62506.30    76566.23    92228.02   109440.80   128167.23   148375.34   170055.53

MAXIMUM STAGE IS     961.3

MAXIMUM STAGE IS     965.4

MAXIMUM STAGE IS     966.9

MAXIMUM STAGE IS     968.2
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MAXIMUM STAGE IS     970.5

MAXIMUM STAGE IS     972.6


          **********          **********          **********          **********          **********

                                         HYDROGRAPH ROUTING

                      CHANNEL ROUTING -MOD PULS- REACH 13-14
                                  ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                     14       1       0       0       0       0       1       0       0
                                                    ROUTING DATA
                         QLOSS    CLOSS     AVG    IRES   ISAME    IOPT    IPMP                  LSTR
                           0.0    0.000    0.00       1       1       0       0                     0

                                  NSTPS   NSTOL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                      1       0       0   0.000   0.000   0.000      0.       0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

        QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
       0.0600  0.0400  0.0600   942.0  1000.0   3300. 0.00180


        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
            0.00  946.00  846.00  946.00  850.00  942.00 1025.00  942.00 1029.00  946.00
         1700.00  960.00 2100.00 1000.00 2101.00 1000.00

  STORAGE         0.00      41.18     226.40     504.62     816.67    1162.55    1542.13    1939.53    2343.99    2755.51
               3174.08    3599.72    4032.42    4472.17    4918.99    5372.86    5833.80    6301.79    6776.84    7258.95

  OUTFLOW         0.00    1778.60    8039.04   24715.16   51046.82   87121.52  133968.88  196793.34  269469.50  351558.31
             442725.38  542709.38  651302.50  768335.38  893669.88 1027191.00 1168803.25 1318425.50 1475991.75 1641446.00

    STAGE       942.00     945.05     948.11     951.16     954.21     957.26     960.32     963.37     966.42     969.47
                972.53     975.58     978.63     981.68     984.74     987.79     990.84     993.89     996.95    1000.00

     FLOW         0.00    1778.60    8039.04   24715.16   51046.82   87121.52  133968.88  196793.34  269469.50  351558.31
             442725.38  542709.38  651302.50  768335.38  893669.88 1027191.00 1168803.25 1318425.50 1475991.75 1641446.00

MAXIMUM STAGE IS     951.7

MAXIMUM STAGE IS     954.9

MAXIMUM STAGE IS     956.2

MAXIMUM STAGE IS     957.4

MAXIMUM STAGE IS     959.3

MAXIMUM STAGE IS     961.0
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          **********          **********          **********          **********          **********

                                               HYDROGRAPH ROUTING

                       CHANNEL ROUTING -MOD PULS- REACH 14-15
                                  ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                                     15        1        0        0        0        0        1        0        0
                                                         ROUTING DATA
                         QLOSS    CLOSS      AVG     IRES    ISAME     IOPT     IPMP             LSTR
                           0.0    0.000     0.00        1        1        0        0                0

                                  NSTPS    NSTDL      LAG    AMSKK        X      TSK    STORA   ISPRAT
                                      1        0        0    0.000    0.000    0.000       0.        0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

          QN(1)    QN(2)    QN(3)    ELNVT    ELMAX    RLNTH      SEL
         0.0600   0.0400   0.0450    937.0   1000.0    3000.  0.00170

          CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
             0.00 1000.00  170.00  960.00 2357.00  945.00 2365.00  937.00 2540.00  937.00
          2548.00  945.00 2800.00  960.00 2900.00 1000.00

  STORAGE       0.00      40.72      82.95     147.66     325.13     625.70    1045.39    1595.95    2195.40    2801.95
             3421.62    4040.39    4664.28    5293.28    5927.39    6566.61    7210.94    7860.38    8514.93    9174.59

  OUTFLOW       0.00    1974.60    6254.13   12780.81   24963.97   46599.53   80694.28  130537.27  206666.56  258135.81
           403804.44  522832.25  654591.88  798580.75  954389.38 1121676.25 1300151.50 1489566.25 1689705.00 1910380.00

    STAGE     937.00     940.32     943.63     946.95     950.26     953.58     956.89     960.21     963.53     966.84
              970.16     973.47     976.79     980.10     983.42     986.74     990.05     993.37     996.68    1000.00

     FLOW       0.00    1974.60    6254.13   12780.81   24963.97   46599.53   80694.28  130537.27  206666.56  258135.81
           403804.44  522832.25  654591.88  798580.75  954389.38 1121676.25 1300151.50 1489566.25 1689705.00 1910380.00

MAXIMUM STAGE IS     951.0

MAXIMUM STAGE IS     954.8

MAXIMUM STAGE IS     956.2

MAXIMUM STAGE IS     957.4

MAXIMUM STAGE IS     959.4

MAXIMUM STAGE IS     961.0

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OK, SEG #HEC1DB


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                                     HYDROGRAPH ROUTING

                 CHANNEL ROUTING -MOD PULS- REACH 15-16
                         ISTAQ     ICOMP     IECON     ITAPE      JPLT      JPRT     INAME    ISTAGE     IAUTO
                            16         1         0         0         0         0         1         0         0
                                                   ROUTING DATA
                 QLOSS     CLOSS       AVG      IRES     ISAME      IOPT      IPMP                LSTR
                   0.0     0.000      0.00         1         1         0         0                   0

                         NSTPS     NSTDL       LAG     AMSKK         X       TSK     STORA    ISPRAT
                             1         0         0     0.000     0.000     0.000        0.         0


NORMAL DEPTH CHANNEL ROUTING
----------------------------

          QN(1)     QN(2)     QN(3)     ELNVT     ELMAX     RLNTH       SEL
         0.0600    0.0400    0.0450     931.0    1000.0     3300.   0.00180

          CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
             0.00 1000.00  500.00  940.00 1300.00  941.00 1701.00  940.00 1710.00  931.00
          1885.00  931.00 1894.00  940.00 2700.00  980.00

STORAGE        0.00      49.14     100.29     283.90     696.47    1137.51    1607.00    2104.95    2631.35    3186.21
            3769.53    4381.30    5021.53    5690.22    6384.78    7090.11    7803.76    8525.74    9256.05    9994.69

OUTFLOW        0.00    2378.86    7574.29   12199.45   42944.45   89873.34  151616.84  227653.31  317790.88  422008.06
          540384.88  673065.00  820236.25  982116.50 1164118.75 1365991.75 1582311.00 1812760.25 2057074.25 2315026.00

STAGE        931.00     934.63     938.26     941.89     945.53     949.16     952.79     956.42     960.05     963.68
             967.31     970.95     974.58     978.21     981.84     985.47     989.10     992.73     996.37    1000.00

FLOW           0.00    2378.86    7574.29   12199.45   42944.45   89873.34  151616.84  227653.31  317790.88  422008.06
          540384.88  673065.00  820236.25  982116.50 1164118.75 1365991.75 1582311.00 1812760.25 2057074.25 2315026.00

MAXIMUM STAGE IS     943.9

MAXIMUM STAGE IS     946.8

MAXIMUM STAGE IS     947.9

MAXIMUM STAGE IS     949.1

MAXIMUM STAGE IS     950.8

MAXIMUM STAGE IS     952.6


            **********          **********          **********          **********          **********

                                     HYDROGRAPH ROUTING

                 CHANNEL ROUTING -MOD PULS- REACH 16-17
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OK, SEG #HEC1DB

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                             17       1       0       0       1       0       0       0       0
                                                ROUTING DATA
                 QLOSS    CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
                   0.0    0.000    0.00       1       1       0       0               0
                          NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                              1       0       0   0.000   0.000   0.000      0.       0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

     QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
    0.0600  0.0400  0.0450   928.0   980.0   1700.  0.00180

     CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
        0.00  980.00 1200.00  940.00 1800.00  935.00 1807.00  928.00 1982.00  928.00
     1989.00  935.00 2200.00  940.00 2300.00  980.00

STORAGE       0.00     18.98     38.55     63.29    128.15    233.25    356.65    477.56    613.96    755.87
            915.28   1080.18   1254.59   1438.49   1631.90   1834.81   2047.22   2269.12   2500.53   2741.44

OUTFLOW       0.00   1476.53   4677.44   9369.77  17457.25  32086.00  53206.49  79928.33 112126.89 149794.44
         192981.84 241773.50 296274.06 356600.94 422880.81 495245.44 573830.75 658775.38 750219.75 848304.50

STAGE       928.00    930.74    933.47    936.21    938.95    941.68    944.42    947.16    945.89    952.63
            955.37    958.10    960.84    963.58    966.32    969.05    971.79    974.53    977.26    980.00

FLOW          0.00   1476.53   4677.44   9369.77  17457.25  32086.00  53206.49  79928.33 112126.89 149794.44
         192981.84 241773.50 296274.06 356600.94 422880.81 495245.44 573830.75 658775.38 750219.75 848304.50

MAXIMUM STAGE IS      941.2

MAXIMUM STAGE IS      945.0

MAXIMUM STAGE IS      946.5

MAXIMUM STAGE IS      947.9

MAXIMUM STAGE IS      950.3

MAXIMUM STAGE IS      952.5


         **********        **********        **********        **********        **********
1
       PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                       FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
                              AREA IN SQUARE MILES (SQUARE KILOMETERS)
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OPERATION	STATION	AREA	PLAN	RATIO 1 0.20	RATIO 2 0.40	RATIO 3 0.50	RATIO 4 0.60	RATIO 5 0.80	RATIO 6 1.00
				RATIOS APPLIED TO FLOWS					
HYDROGRAPH AT	1	79.10	1	10827.	21655.	27068.	32482.	43309.	54137.
	(	204.87)	(	306.60)(	613.19)(	766.49)(	919.79)(	1226.38)(	1532.98)(
ROUTED TO	B	79.10	1	10721.	21441.	26801.	32162.	42882.	53603.
	(	204.87)	(	303.57)(	607.14)(	758.93)(	910.71)(	1214.29)(	1517.86)(
HYDROGRAPH AT	2	71.10	1	9652.	19304.	24130.	28956.	38608.	48260.
	(	184.15)	(	273.31)(	546.63)(	683.28)(	819.94)(	1093.25)(	1366.56)(
2 COMBINED	B	150.20	1	19627.	39255.	49069.	58882.	78510.	98137.
	(	389.01)	(	555.79)(	1111.57)(	1389.47)(	1667.36)(	2223.15)(	2778.94)(
HYDROGRAPH AT	3	29.50	1	6483.	12966.	16208.	19449.	25932.	32415.
	(	76.40)	(	183.58)(	367.16)(	458.95)(	550.74)(	734.32)(	917.90)(
2 COMBINED	B	179.70	1	22684.	45368.	56710.	68052.	90735.	113419.
	(	465.42)	(	642.33)(	1284.67)(	1605.84)(	1927.00)(	2569.34)(	3211.67)(
ROUTED TO	C	179.70	1	21801.	43602.	54503.	65403.	87204.	109006.
	(	465.42)	(	617.34)(	1234.68)(	1543.35)(	1852.01)(	2469.35)(	3086.69)(
HYDROGRAPH AT	4	100.30	1	16919.	33838.	42298.	50757.	67676.	84595.
	(	259.77)	(	479.09)(	958.19)(	1197.73)(	1437.28)(	1916.37)(	2395.46)(
2 COMBINED	C	280.00	1	29655.	59310.	74138.	88966.	118621.	148276.
	(	725.19)	(	839.74)(	1679.48)(	2099.35)(	2519.22)(	3358.96)(	4198.71)(
ROUTED TO	UTFLOW	280.00	1	29621.	59250.	74054.	88855.	118449.	148018.
	(	725.19)	(	838.76)(	1677.78)(	2096.98)(	2516.08)(	3354.11)(	4191.39)(
ROUTED TO	1	280.00	1	29634.	59263.	74043.	88826.	118429.	148010.
	(	725.19)	(	839.14)(	1678.14)(	2096.67)(	2515.26)(	3353.53)(	4191.17)(
ROUTED TO	2	280.00	1	29639.	59254.	74043.	88850.	118441.	148018.
	(	725.19)	(	839.29)(	1677.89)(	2096.66)(	2515.96)(	3353.86)(	4191.41)(
ROUTED TO	3	280.00	1	29624.	59255.	74051.	88840.	118484.	148084.
	(	725.19)	(	838.85)(	1677.91)(	2096.89)(	2515.67)(	3355.08)(	4193.26)(
ROUTED TO	4	280.00	1	29633.	59231.	74131.	88837.	118458.	148161.
	(	725.19)	(	839.10)(	1677.23)(	2099.16)(	2515.59)(	3354.34)(	4195.45)(
ROUTED TO	5	280.00	1	29625.	59286.	74073.	88934.	118489.	148186.
	(	725.19)	(	838.88)(	1678.80)(	2097.52)(	2518.33)(	3355.24)(	4196.17)(
ROUTED TO	6	280.00	1	29618.	59255.	74028.	88977.	118493.	148117.
	(	725.19)	(	838.70)(	1677.91)(	2096.24)(	2519.55)(	3355.34)(	4194.21)(
ROUTED TO	7	280.00	1	29618.	59245.	74035.	88965.	118572.	148045.
	(	725.19)	(	838.70)(	1677.62)(	2096.45)(	2519.22)(	3357.59)(	4192.17)(
ROUTED TO	8	280.00	1	29621.	59243.	74021.	88959.	118636.	148053.
	(	725.19)	(	838.77)(	1677.57)(	2096.03)(	2519.03)(	3359.41)(	4192.40)(

ROUTED TO	9	280.00	1	29605.	59234.	74084.	88869.	118686.	148116.
		(725.19)		(838.32)(	1677.32)(	2097.82)(	2516.49)(	3360.80)(	4194.18)(
ROUTED TO	10	280.00	1	29580.	59288.	74072.	88903.	118519.	148127.
		(725.19)		(837.60)(	1678.85)(	2097.47)(	2517.45)(	3356.09)(	4194.48)(
ROUTED TO	11	280.00	1	29589.	59293.	74066.	88841.	118466.	148164.
		(725.19)		(837.87)(	1678.98)(	2097.32)(	2515.69)(	3354.59)(	4195.53)(
ROUTED TO	12	280.00	1	29612.	59215.	74065.	88778.	118429.	148015.
		(725.19)		(838.52)(	1676.78)(	2097.29)(	2513.91)(	3353.52)(	4191.32)(
ROUTED TO	13	280.00	1	29606.	59230.	74004.	88758.	118344.	148084.
		(725.19)		(838.36)(	1677.22)(	2095.57)(	2513.33)(	3351.14)(	4193.26)(
ROUTED TO	14	280.00	1	29614.	59194.	74037.	88734.	118340.	148042.
		(725.19)		(838.58)(	1676.19)(	2096.48)(	2512.68)(	3351.00)(	4192.07)(
ROUTED TO	15	280.00	1	29567.	59187.	74062.	88768.	118367.	147940.
		(725.19)		(837.25)(	1675.97)(	2097.19)(	2513.63)(	3351.77)(	4189.19)(
ROUTED TO	16	280.00	1	29555.	59192.	74100.	88798.	118346.	148035.
		(725.19)		(836.89)(	1676.13)(	2098.28)(	2514.47)(	3351.19)(	4191.99)(
ROUTED TO	17	280.00	1	29608.	59324.	73943.	88841.	118379.	147976.
		(725.19)		(838.41)(	1679.88)(	2093.83)(	2515.70)(	3352.11)(	4190.22)(

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOF OF DAM
ELEVATION	1093.70	1093.70	1103.80
STORAGE	52.	52.	513.
OUTFLOW	0.	0.	23192.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	1105.48	1.68	654.	29621.	12.00	51.00	0.00
0.40	1110.62	6.82	1267.	59250.	21.00	51.00	0.00
0.50	1112.62	8.82	1590.	74054.	24.00	51.00	0.00
0.60	1114.47	10.67	1933.	88855.	26.00	51.00	0.00
0.80	1117.81	14.01	2682.	118449.	29.00	51.00	0.00
1.00	1120.87	17.07	3518.	148018.	32.00	51.00	0.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29634.	1075.8	52.00
0.40	59263.	1080.5	51.00
0.50	74043.	1082.3	51.00
0.60	88826.	1084.0	51.00
0.80	118429.	1087.0	51.00

1.00	148010.	1089.7	52.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29639.	1065.7	51.00
0.40	59254.	1069.1	51.00
0.50	74043.	1070.5	51.00
0.60	88850.	1071.7	51.00
0.80	118441.	1074.1	52.00
1.00	148018.	1076.2	52.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29624.	1052.5	52.00
0.40	59255.	1057.8	52.00
0.50	74051.	1059.7	52.00
0.60	88840.	1061.5	52.00
0.80	118484.	1064.6	52.00
1.00	148084.	1067.3	52.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29633.	1044.3	52.00
0.40	59231.	1049.2	52.00
0.50	74131.	1051.0	52.00
0.60	88837.	1052.7	52.00
0.80	118458.	1055.6	52.00
1.00	148161.	1058.2	52.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29625.	1037.8	52.00
0.40	59286.	1041.8	52.00
0.50	74073.	1043.2	52.00
0.60	88934.	1044.6	52.00
0.80	118489.	1047.0	52.00
1.00	148186.	1049.2	52.00

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29618.	1034.2	52.00
0.40	59255.	1039.7	52.00

0.50	74028.	1041.5	52.00
0.60	88977.	1043.0	52.00
0.80	118493.	1045.9	52.00
1.00	148117.	1048.4	52.00

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29618.	1030.2	52.00
0.40	59245.	1034.9	52.00
0.50	74035.	1036.6	52.00
0.60	88965.	1038.1	52.00
0.80	118572.	1040.6	52.00
1.00	148045.	1042.7	52.00

PLAN 1 STATION 8

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29621.	1024.0	52.00
0.40	59243.	1027.1	52.00
0.50	74021.	1028.4	52.00
0.60	88959.	1029.6	52.00
0.80	118636.	1031.6	52.00
1.00	148053.	1033.5	52.00

PLAN 1 STATION 9

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29605.	1021.3	52.00
0.40	59234.	1025.2	52.00
0.50	74084.	1026.6	52.00
0.60	88869.	1028.1	52.00
0.80	118686.	1030.3	52.00
1.00	148116.	1032.5	52.00

PLAN 1 STATION 10

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29580.	1006.0	53.00
0.40	59288.	1012.9	52.00
0.50	74072.	1015.7	52.00
0.60	88903.	1018.1	52.00
0.80	118519.	1022.4	52.00
1.00	148127.	1026.3	52.00

PLAN 1 STATION 11

MAXIMUM MAXIMUM TIME

RATIO	FLOW,CFS	STAGE,FT	HOURS
0.20	29589.	995.1	53.00
0.40	59293.	1000.7	52.00
0.50	74066.	1002.6	52.00
0.60	88841.	1004.6	52.00
0.80	118466.	1007.8	52.00
1.00	148164.	1010.8	52.00

PLAN 1 STATION 12

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29612.	974.4	53.00
0.40	59215.	980.8	53.00
0.50	74065.	983.0	52.00
0.60	88778.	985.1	53.00
0.80	118429.	988.8	52.00
1.00	148015.	992.2	52.00

PLAN 1 STATION 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29606.	961.3	53.00
0.40	59230.	965.4	53.00
0.50	74004.	966.9	52.00
0.60	88758.	968.2	53.00
0.80	118344.	970.5	52.00
1.00	148084.	972.6	52.00

PLAN 1 STATION 14

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29614.	951.7	53.00
0.40	59194.	954.9	53.00
0.50	74037.	956.2	53.00
0.60	88734.	957.4	53.00
0.80	118340.	959.3	53.00
1.00	148042.	961.0	52.00

PLAN 1 STATION 15

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29567.	951.0	53.00
0.40	59187.	954.8	53.00
0.50	74062.	956.2	53.00
0.60	88768.	957.4	53.00
0.80	118367.	959.4	53.00
1.00	147940.	961.0	52.00

PLAN 1 STATION 16

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29555.	943.9	54.00
0.40	59192.	946.8	53.00
0.50	74100.	947.9	53.00
0.60	88798.	949.1	53.00
0.80	118346.	950.8	53.00
1.00	148039.	952.6	53.00

PLAN 1 STATION 17

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	29608.	941.2	53.00
0.40	59324.	945.0	53.00
0.50	73943.	946.5	53.00
0.60	88841.	947.9	53.00
0.80	118379.	950.3	53.00
1.00	147976.	952.5	53.00

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1********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
 ********************************
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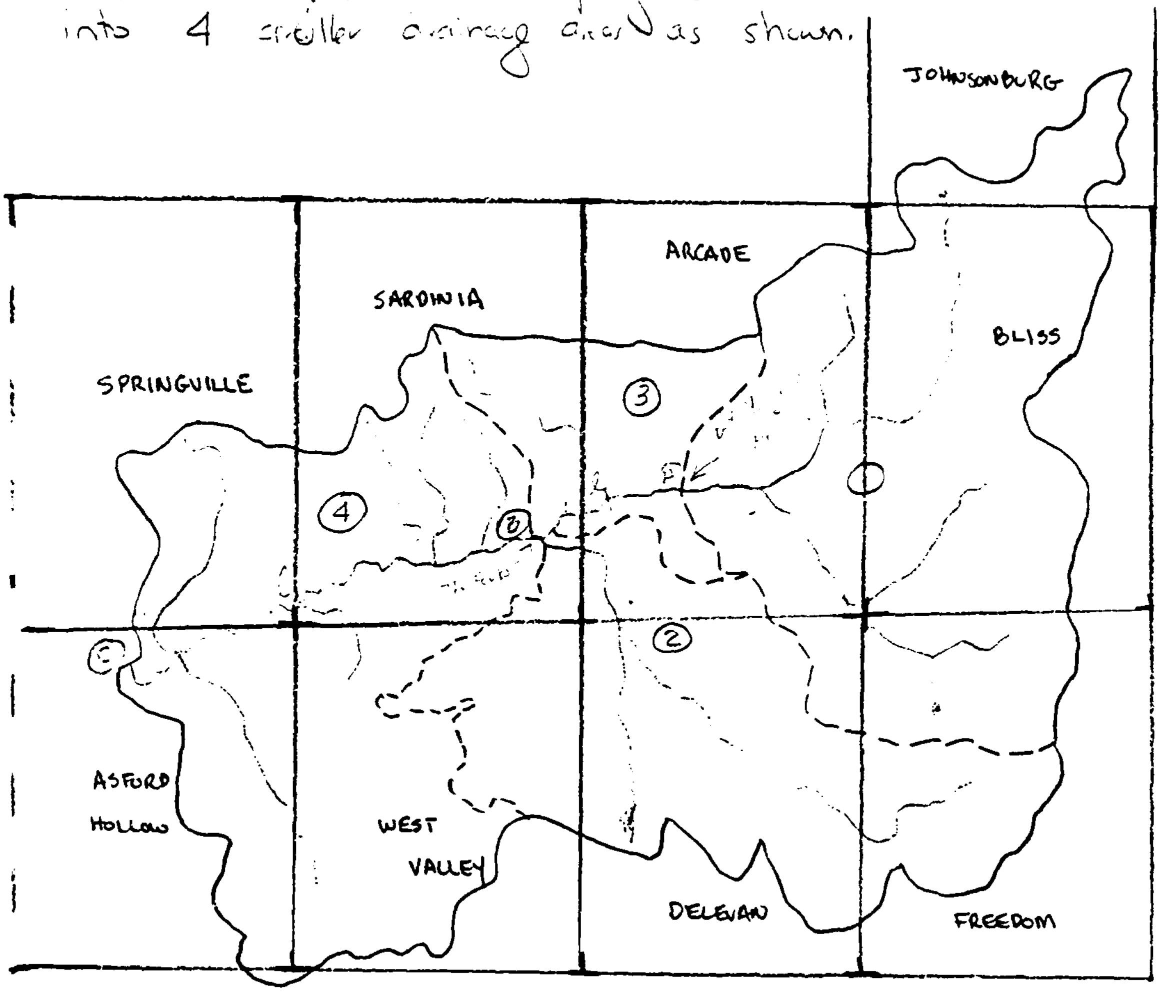
BY [illegible] DATE 5/12/81 **ERDMAN, ANTHONY, ASSOCIATES** SHEET 1 OF [illegible]
CD G.R. DATE 5/28/81 SUBJECT Dam 704 - Hydrology SUB-SHEET NO. 1
OWNER PROJECT NAME Dam Inspection (50166-00.1C)

Dam 704 - Hydrology

The drainage area for Springville Dam was subdivided into 4 smaller drainage areas as shown.



Summary of Required Data

Sub Area or Reach	Drainage Area (mi²)	Lc MILES	Lca MILES	PMP Rainfall (24 Hr. in.)	REACH LENGTH ℓ	Slope S	Muskingum Coef. K	Muskingum Coef. x
1	79.1 (1)	16.17	9.47	22.2				
A to B					23000'	.0059	0.74	0.2
2	71.1 (2)	15.78	10.26	22.2				
3	29.5	7.30	2.56	22.2				
B to C					71,600'	.0027	2.35	0.2
4	100.3	13.81	4.73	22.2				
	280.0 ✓							

BY [illegible] DATE 5/12/81 **ERDMAN, ANTHONY, ASSOCIATES** SHEET 2 OF [illegible]

D B.R. DATE 5/21/81 SUBJECT Dam 704 - Hydrology SUB-SHEET NO. 2

OWNER PROJECT NAME [illegible] (80166-CC.10)

Footnotes:

(1) "Surface Water Records of New York - 1963" U.S. Dept. of Interior, Geological Survey - Water Resources Division, p 208.

(2) "Surface Water Records of New York - 1964" U.S. Dept. of Interior, Geological Survey - Water Resources Division, p. 344.

Routing

	Hydrograph
Compute runoff [illegible] for 1	1
Route 1 to point A [illegible]	1R
Compute runoff [illegible] for 2	2
Combine 1R and 2 at point A	1R+2
Compute runoff [illegible] for 3	3
Combine 1R+2 and 3	123
Route 1R+2+3 to dam	123R
Compute runoff [illegible] for 4	4
Combine 4 with 123R	1234R

AD-A105 799 ERDMAN ANTHONY ASSOCIATES ROCHESTER NY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. SPRINGVILLE DAM (INVENTORY NUMBER --ETC(U)
AUG 81 R J FARRELL DACW51-81-C-0017
UNCLASSIFIED NL

2 OF 2
AD A
105799

END
DATE
FILMED
11-81
DTIC

F.L.D.	DATE 5/13/81	**ERDMAN, ANTHONY, ASSOCIATES**		SHEET 3	OF 24
CKD G.R.	DATE 5/15/81	SUBJECT Dam 704 Hydrology		SUB-SHEET NO. 3	
OWNER		PROJECT NAME HEC-1DB Dam Inspection		53166-00-10	

SUB AREA HYDROLOGY

DAM # 704 SPRINGVILLE DAM SUB-SECT. #1, #2, #3 & #4

DRAINAGE DISTANCE SCALE 1" = 250,000"

SUB-AREA #1

№ 1	=	MEAS. DIST.	×	COEF	=	L-DISTANCE		
LENGTH	=	4.1"	×	250,000	=	1,025,000"	=	85,417 ft
CENTROID						Lca DISTANCE		
DISTANCE	=	2.4"	×	250,000"	=	600,000"	=	50,000 ft

SUB-AREA #2

№ 2						L-DISTANCE		
LENGTH	=	4.0	×	250,000	=	1,000,000"	=	83333 ft
CENTROID						Lca		
DISTANCE	=	2.6	×	250,000	=	650,000"	=	54167 ft

SUB-AREA #3

№ 3						L-DISTANCE		
LENGTH	=	1.85	×	250,000	=	462,500"	=	38542 ft
CENTROID						Lca DISTANCE		
DISTANCE	=	0.65	×	250,000	=	162,500	=	13542 ft

SUB-AREA #4

№ 4						L-DISTANCE		
LENGTH	=	3.5	×	250,000	=	875,000"	=	72917 ft
CENTROID								
DISTANCE	=	1.2	×	250,000	=	300,000"	=	25000 ft

SUB - AREA NO. 1

DETERMINATION OF SNYDER'S LAG TIME

$$t_p = C_t (L \cdot L_{ca})^{0.3} \quad , \quad C_t = 2.00$$

$$C_p = 0.63$$

$$t_r = \frac{t_p}{5.5}$$

$$t_{pR} = t_p + 0.25 (t_R - t_r)$$

$$L = 85{,}417' \checkmark = \frac{85{,}417'}{5280} = 16.18 \text{ MILES} \checkmark$$

$$L_{ca} = 50{,}000' \checkmark = \frac{50000'}{5280} = 9.47 \text{ MILES} \checkmark$$

$$t_p = 2 (L \times L_{ca})^{0.3} = 9.05 \text{ hrs.} \checkmark$$

$$t_r = \frac{9.05}{5.5} = 1.65 \text{ hrs.} \longrightarrow t_R = 1 \text{ hrs} \checkmark$$

$$t_{pR} = 9.05 + 0.25 (1 - 1.65) = 8.89 \text{ hrs.} \checkmark$$

SUB - AREA NO. 2

DETERMINATION OF SNYDER'S LAG TIME

$$L = 1000000'' = \frac{1000.000}{5280 \times 12} = 15.78 \text{ MILES} \checkmark$$

$$L_{ca} = 650,000'' = \frac{650.000}{5280 \times 12} = 10.26 \text{ MILES} \checkmark$$

$$t_p = 2 \; (L_c \times L_{ca})^{0.3} = 9.20 \text{ hrs} \checkmark$$

$$t_r = \frac{9.20}{5.5} = 1.67 \text{ hrs.} \checkmark \Longrightarrow t_R = 1 \text{ hrs} \checkmark$$

$$t_{PR} = 9.20 + 0.25\,(1 - 1.67) = 9.03 \text{ hrs.} \checkmark$$

SUB - AREA NO. 3

DETERMINATION OF SNYDER'S LAG TIME

$$L = 462{,}500'' = \frac{462{,}500}{5280 \times 12} = 7.30 \text{ Miles} \checkmark$$

$$L_{ca} = 162{,}500'' = \frac{162\,500}{5280 \times 12} = 2.56 \text{ Miles} \checkmark$$

$$t_p = 2\,(L \times L_{ca})^{0.3} = 4.81 \text{ hrs} \checkmark$$

$$t_r = \frac{4.81}{5.5} = 0.8\cancel{6}7 \text{ hrs.} \checkmark \rightarrow t_R = 1 \text{ hrs.} \checkmark$$

$$t_{PR} = 4.81 + 0.25\,(1 - 0.8\cancel{6}7) = 4.8\cancel{3}4 \text{ hrs.} \checkmark$$

SUB AREA NO. 4

DETERMINATION OF SNYDER'S LAG TIME

$$L = 875{,}000'' = \frac{875{,}000}{5280 \times 12} = 13.81 \text{ MILES}$$

$$L_{ca} = 300{,}000'' = \frac{300{,}000}{5280 \times 12} = 4.73 \text{ MILES}$$

$$t_p = 2(L \times L_{ca})^{0.3} = 7.01 \text{ hrs}$$

$$t_r = \frac{7.01}{5.5} = 1.27 \text{ hrs.} \longrightarrow t_R = 1 \text{ hrs.}$$

$$t_{pR} = 7.01 + 0.25(1 - 1.27) = 6.94 \text{ hrs.}$$

SPRINGVILLE DAM - MUSKINGUM METHOD
ROUTING & SLOPE

REF. QUAD MAPS ARCADE, SALDINIA & ASHFORD HOLLOW
SCALE HORIZ. 1" = 2000'

SUB-SECTION Nº 2 CATTARAUGUS CREEK

REACH LENGTH

MEAS. LENGTH # 1 = 11.6
" " # 2 = 11.4

AVG. 23.0 ÷ 2 = 11.5 × 2000' ft = 23,000 ft

SLOPE

START of REACH CONTOUR 1395
END of REACH CONTOUR 1260

135 ft ÷ 23,000 ft = 0.0059

SUB-SECTION Nº 4 CATTARAUGUS CREEK

REACH LENGTH

MEAS. LENGTH # 1 = 35.8
" " # 2 = 35.8

AVG 71.6 ÷ 2 = 35.8 × 2000 ft = 71,600 ft.

SLOPE

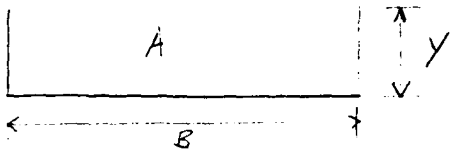
START of REACH CONTOUR 1260
END AT DAM 1065

195 ÷ 71,600 ft = 0.0027

MUSKINGUM ROUTING

DETERMINATION OF K

ASSUMPTIONS:



ASSUME RECTANGULAR CROSS SECTION

$Q = 1.5$ cfs/AC

$n = 0.06$,

$R = y$ (HYDRAULIC RADIUS = CHANNEL DEPTH)

$$Q = \frac{1.49}{n} A R^{2/3} S_o^{1/2}$$

① $$Q = \frac{1.49}{n} B y y^{2/3} S_o^{1/2} = \frac{1.49}{n} B y^{5/3} S_o^{1/2}$$

SOLVE EQ. ① FOR y : $y = \left[\frac{nQ}{1.49 S_o^{1/2} B}\right]^{3/5}$ ✓

$$\left.\begin{array}{l} A = yB \\ V = \dfrac{Q}{A} \\ k = T = \dfrac{L}{V} \\ y = \left[\dfrac{n\,Q}{1.49\,S_o^{1/2}\,B}\right]^{3/5} \\ n = 0.06\ ✓ \end{array}\right\} \longrightarrow K = 0.146\,L\,B^{\frac{2}{5}}\,Q^{-\frac{2}{5}}\,S_o^{-0.3}$$ ✓

note: $k \cong$ Travel Time

$$\therefore\ K = \frac{L}{\dfrac{Q}{B\left[\frac{nQ}{1.49 S_o^{1/2} B}\right]^{3/5}}}$$

REACH A-B

$$K = 0.146\, L\, B^{\frac{2}{5}}\, Q^{-\frac{2}{5}}\, S_o^{-0.3}$$

$Q \cong 1.5 \times 79.1 \times 640 = 75936$ cfs ✓

ASSUME AN AVERAGE OF 900' FOR B ✓

$l = 23000'$ ✓ , $S_o = 0.0059$ ✓

$$K = 0.146 \times 23000' \times 900^{\frac{2}{5}} \times 75936^{-\frac{2}{5}} \times 0.0059^{-0.3}$$

$K = 2656.7$ SEC. $= 0.74$ hrs. ✓

REACH B-C

$A = 79.1 + 71.1 + 29.5 = 179.70$ MILE^2 $= 115008.$ ac.

$Q \cong 1.5 \times 115008 = 172,512$ cfs ✓

$l = 71600'$ ✓ , $S_o = 0.0027$ ✓

ASSUME AN AVERAGE OF 1200' FOR B ✓

$$K = 0.146 \times 71600 \times 1200^{\frac{2}{5}} \times 172512^{-2/5} \times 0.0027^{-0.3} = 8448.93$$

$K = 2.35$ hrs ✓

MUSKINGUM ROUTING

CHECK THE VALUE OF K

REACH AB

ASSUME $\Delta T = \frac{K}{2}$ $\longrightarrow$ $\Delta T = \frac{0.74}{2} = .37$ hr. ✓

where 2 = # of computation intervals.

$X = 0.2$

$$\frac{\Delta T}{2(1-X)} \leqslant K \leqslant \frac{\Delta T}{2X} \quad \text{(REF. HEC-1.)}$$

$$\frac{.37}{2(1-0.2)} < 0.74 < \frac{.37}{2 \times 0.2}$$

$$0.23 < 0.74 < 0.93 \quad \text{O.K.} ✓$$

REACH BC

ASSUME $\Delta T = \frac{K}{3}$ $\longrightarrow$ $\Delta T = \frac{2.35}{3} = 0.78$ hr. ✓

where 3 = # of computation intervals.

$X = 0.2$

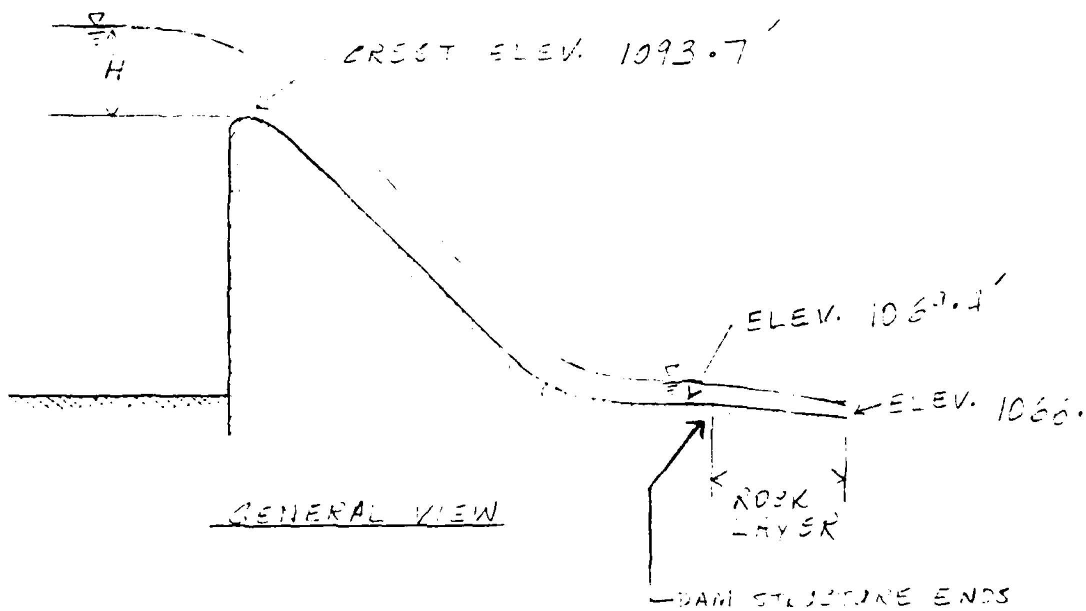
$$\frac{0.78}{2(1-.2)} < 0.78 < \frac{0.78}{2 \times 0.2}$$

$$0.49 < 0.78 < 1.95 \quad \text{O.K.} ✓$$

BY		DATE		**ERDMAN, ANTHONY, ASSOCIATES**	SHEET 12 OF 24
CD		DATE		SUBJECT	SUB-SHEET NO. 1
OWNER				PROJECT NAME	1016

OVERFLOW SPILLWAY HYDRAULICS

REF. OPEN CHANNEL FLOW BY HENDERSON PAGE 180



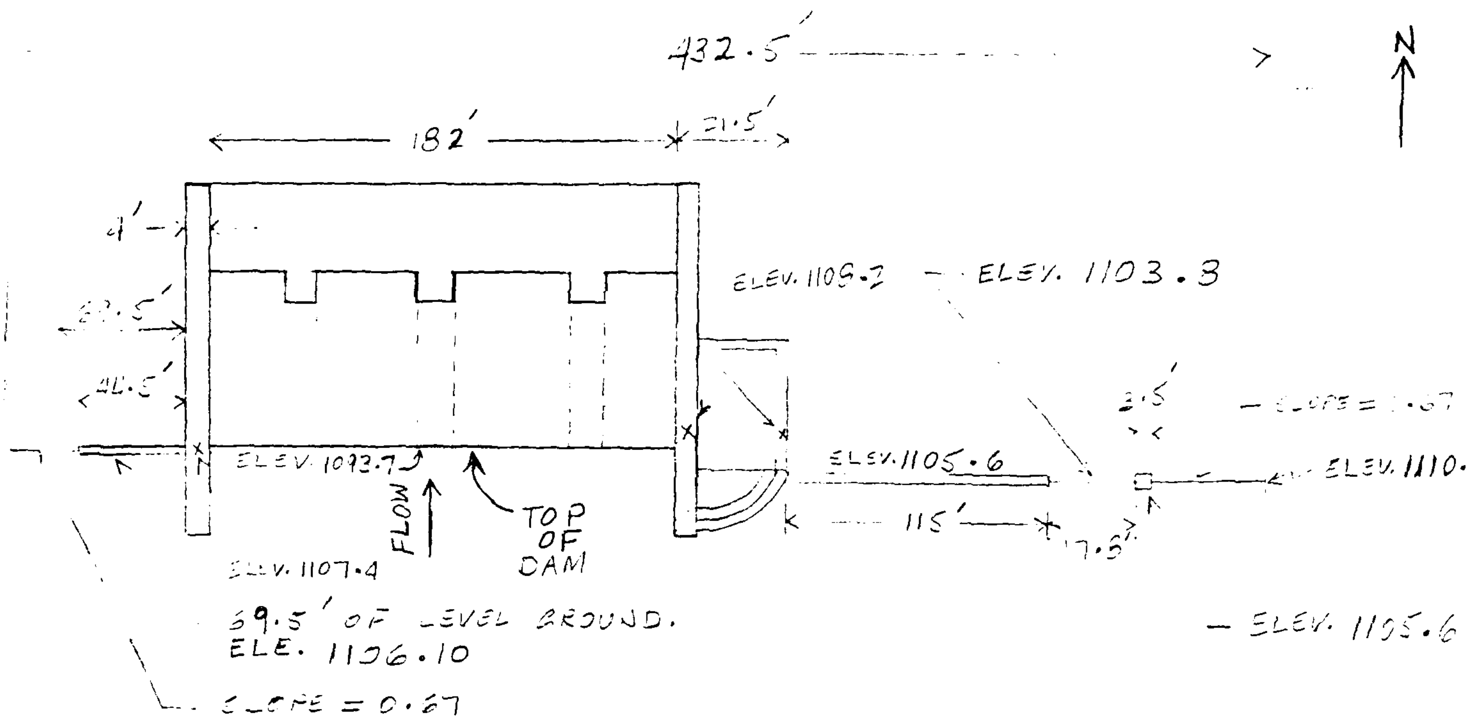
GENERAL VIEW

$$q = 3.97\,H^{3/2}$$ PER UNIT WIDTH.

ASSUMPTIONS:

1) 3 OPENINGS ON THE BOTTOM OF DAM ARE PLUGGED WITH BEAMS.

2) POWER PLANT'S INTAKE CHANNELS ARE CLOSED DURING FLOODING EVENTS



PLAN VIEW

$$q = 3.97\,H^{3/2} \text{ per unit width}$$

$$Q = 3.97\,H^{3/2} \times 182'$$

$$\boxed{Q = 722.54\,H^{3/2}}$$

BY [illegible] DATE [illegible] **ERDMAN, ANTHONY, ASSOCIATES** SHEET 14 OF 24

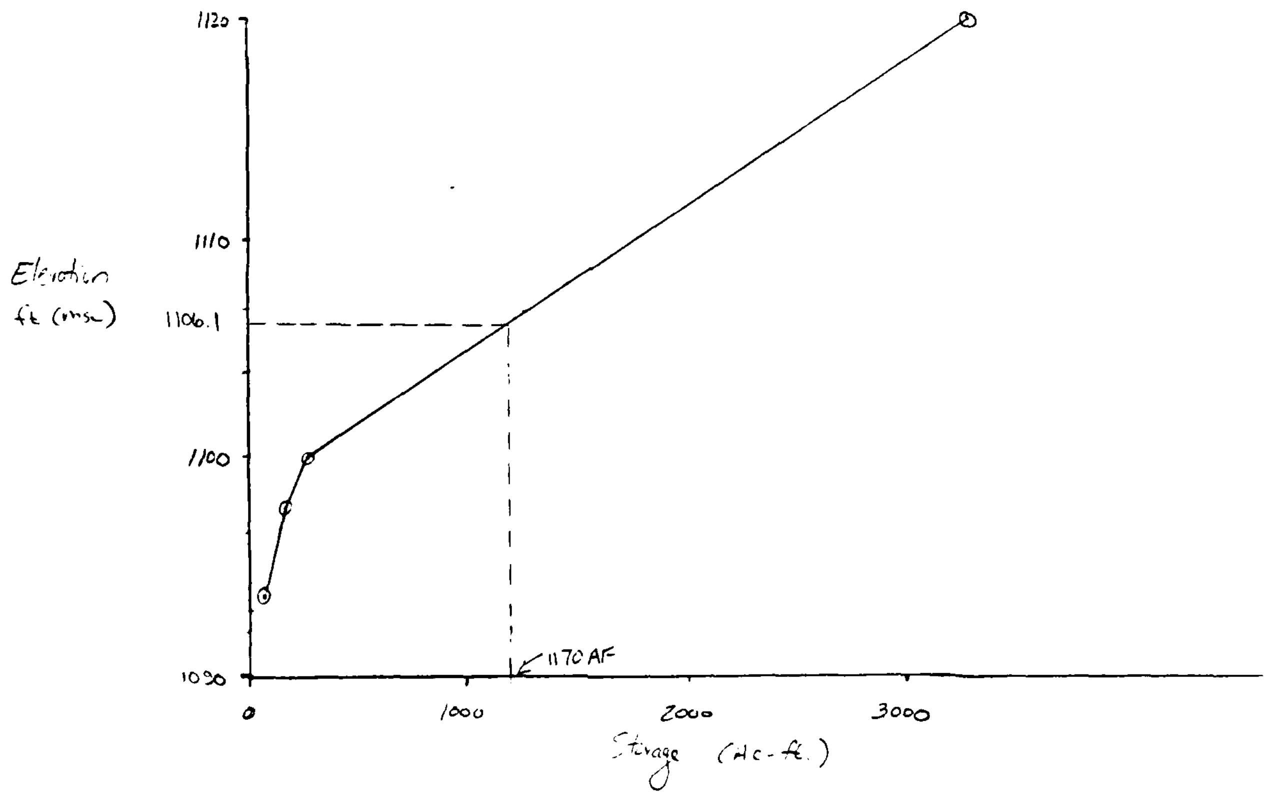
KD [illegible] DATE [illegible] SUBJECT DAM [illegible] HYDRAULICS SUB-SHEET NO. 3

OWNER PROJECT NAME DAM INSPECTION [illegible] 70167-00.10

T. P. ELEV. 115 = 1093.7 FILE 3-10-D SHEETS 2 OF 25 & 9 OF 25

(TO - O - DAM)

ELEVATION STORAGE AREA RELATIONSHIP	
ELEVATION	RESERVOIR SURFACE AREA
1090.7	13 AC.
1093.7	22 AC.
1097.7	42 AC.
1100	47 AC
1120	285 AC



BY [illegible] DATE [illegible] **ERDMAN, ANTHONY, ASSOCIATES** SHEET 15 OF 34
CK [illegible] DATE [illegible] SUBJECT [illegible] HYDRAULICS SUB-SHEET NO. 4
OWNER PROJECT NAME [illegible] 80166-00.10

REFS. FILE 8-10-D SHEETS 2, 5, 9 OF 25
USGS. CONTOUR MAPS

	DISCHARGE ELEVATION RELATIONSHIP $Q = 722.54\,H^{1.5}$			STORAGE AREA
	ELEVATION	H (ft)	Q (cfs)	
1	1093.7	0	0	22 AC
2	1095	1.3	1071	28 AC
3	1097	3.3	4331	38 AC
4	1097.7	4.0	5780	42 AC.
5	1100	6.3	11425	57 AC.
6	1102	8.3	17277	
7	1103.8	10.10	23192	
8	1105.6	11.9	29661	
9	1106.1	12.4	31550	
10	1107.4	13.7	36639	
11	1108.2	14.5	39895	
12	1110.6	16.9	50199	
13	1113	19.3	61263	
14	1115	21.3	71028	
15	1117	23.3	81264	
16	1120	26.3	97453	285 AC
17	1122	28.3	108778	
18	1123.7	30.0	118725	
19	1124	30.3	120511	
20	1125	31.3	126526	

INITIAL STORAGE AREA ON Y1-7 card
ELEV. 1093.7 STORAGE AREA = 22

Dam overtopping Data is contained on the one V cards and overtopping begins at elevation 1103.8.

SPRINGVILLE DAM

REFF. QUAD MAP - COLLINS CENTER N.Y.
ASHFORD HOLLOW N.Y.

... TOP ELEV. 132.. REFF. FILE 3-10-D SHEET 6 OF 25
DAM IN. ELEV. ~~93.7~~ @ APRON REFF. " " SHEET 2 OF 25
10.1

* FOR DAM ELEVATIONS SEE NOTE FILE 3-10-D SHEET 9 OF 25
CREST ELEVATION ~~115.5~~ 114.5 = 1089.66 OF THE 1930 DAM. 1069.36
SO IF 115.0 = ~~1059.66~~ 1093.66 THEN 132.0 = 1103.66 & 93.7 = ~~1066.22~~

DAM TOP ELEV. = ~~1103.66~~ USE ~~1103.7~~ 1112.7
DAM INV. ELEV. = ~~1066.22~~ 1066.1 USE ~~1066.2~~ 1066.1

REACH 1 LENGTH = 1000'

CROSS SECT. 1070/0 1067/430 1055/440 1055/610 1067/650 1080/900 1100/1100 1100/1101

SLOPE: DAM INV. - RE. 1 INV. = h ÷ L = SLOPE
~~1066.2~~ 1066.1 - 1055 = ~~10.3'~~ 11.10 ÷ 1000' = ~~0.0103~~ 0.0111

REACH 2 LENGTH = 1000'

CROSS SECT. ~~1060/0 1059/530 1049/340 1049/540 1059/550 1060/650 1055/900 1100/1100~~ ✓

SLOPE: RE. 1 INV. - RE. 2 INV. = h ÷ L = SLOPE
1055 - 1049 = 6 ÷ 1000' = 0.006

CROSS SECT.	1060	1060	1059	1049	1049	1059	1060	1100
	0	900	1000	1010	1210	1220	1300	1700

CONTINUED ON SHEET 2

BY D.L.S. DATE ... **ERDMAN, ANTHONY, ASSOCIATES** SHEET 17 OF 24

CKD BY ... DATE ... SUBJECT ... SUB-SHEET NO. 2

OWNER PROJECT NAME ...

SPRINGVILLE DAM

REACH 3 LENGTH = 5100'

CROSS SECT. 1055 / 0, 1048 / 590, 1035 / 600, 1035 / 800, 1048 / 510, 1060 / 900, 1030 / 1000, 1100 / 1100

SLOPE: RE. 2 INV. − RE. 3 INV. = h ÷ L = SLOPE

1049 − 1035 = 12' ÷ 5100' = 0.0022

REACH 4 LENGTH = 2720'

CROSS SECT. 1030 / 0, 1040 / 300, 1035 / 314, 1032 / 320, 1032 / 520, 1038 / 526, 1040 / 600, 1048 / 1000

SLOPE: RE. 3 INV. − RE. 4 INV. = h ÷ L = SLOPE

1035 − 1032 = 6 ÷ 2720' = 0.0022

REACH 5 LENGTH = 4200'

CROSS SECT. 1027 / 0, 1031 / 614, 1031 / 776, ... / 620, 1025 / 770, 1040 / 1020, 1060 / 1130, 1100 / 1400

SLOPE: RE. 4 INV. − RE. 5 INV. = h ÷ L = SLOPE

1032 − 1025 = 7 ÷ 4200' = 0.0017

REACH 6 LENGTH = 3800'

CROSS SECT. 1130 / 0, 1066 / 175, 1040 / 260, 1025 / 359, 1019 / 365, 1019 / 540, 1025 / 546, 1040 / 1150

SLOPE: RE. 5 INV. − RE. 6 INV. = h ÷ L = SLOPE

1025 − 1019 = 6 ÷ 3800 = 0.0016

CONTINUED ON SHEET 3

BY [illegible] DATE [illegible] **ERDMAN, ANTHONY, ASSOCIATES** SHEET 18 OF 24

CHKD [illegible] DATE [illegible] SUBJECT [illegible] 704 [illegible] SUB-SHEET NO. 3

OWNER PROJECT NAME [illegible] [illegible]

[illegible]

REACH 7 LENGTH = 900'   1023/574

CROSS SECT: 1023/0 1025/500 1017/580 1017/755 1023/761 1040/1200 1045/1500

SLOPE: RE. 6 INV. - RE. 7 INV. = H ÷ L = SLOPE

1019 - 1017 = 2 ÷ 900' = 0.0022

REACH 8 LENGTH = 1000'   1018/688

CROSS SECT: 1018/0 1018/507 1015/510 1015/685 1020/975 1030/1400 1040/1800

SLOPE: RE. 7 INV. - RE. 8 INV. = H ÷ L = SLOPE

1017 - 1015 = 2 ÷ 1000 = 0.002

REACH 9 LENGTH = 700'   1016/326

CROSS SECT: 1013/0 1012/330 1012/370 [illegible] 1012/[illegible] [illegible] 1020/[illegible] 1040/[illegible]

SLOPE: RE. 8 INV. - RE. 9 INV. = H ÷ L = SLOPE

1014 - 1012 = 2' ÷ 700' = 0.0029

REACH 10 LENGTH = 1200'

CROSS SECT: 1023/0 1015/500 1010/570 1010/930 1045/1400

SLOPE: RE. 9 INV. - RE. 10 INV. = H ÷ L = SLOPE

1013 - 1010 = 3 ÷ 1200' = 0.0025

CONTINUED ON SHEET 4

[illegible]INGSVILLE DAM

9 2700

REACH 9 LENGTH = 1000' 1017 340

CROSS SECT. $\frac{1100}{0}$ $\frac{1020}{310}$ ^ $\frac{1004}{350}$ $\frac{1009}{525}$ $\frac{1017}{533}$ $\frac{1020}{1400}$ $\frac{1100}{1300}$

SLOPE: RE. 10 INV. - RE. 11 INV. = h ÷ L = SLOPE
1015 − 1009 = 6 ÷ 2700 = 0.0022

11

REACH 11 LENGTH = 7300' $\frac{1000}{478}$

CROSS SECT. $\frac{1100}{0}$ $\frac{1020}{150}$ $\frac{1000}{272}$ $\frac{992}{230}$ $\frac{[illegible]}{470}$ ^ $\frac{1020}{[illegible]}$ $\frac{1100}{[illegible]}$

SLOPE: RE. 11 INV. - RE. 12 INV. = h ÷ L = SLOPE
1009 − 992 = 17 ÷ 7300' = 0.0023

REACH 12 LENGTH = 4340 $\frac{988}{633}$

CROSS SECT. $\frac{997}{0}$ $\frac{988}{442}$ $\frac{980}{455}$ $\frac{980}{625}$ ^ $\frac{1000}{675}$ $\frac{1100}{1500}$ $\frac{1100}{1001}$

SLOPE: RE. 12 INV. - RE. 13 INV. = h ÷ L = SLOPE
992 − 980 = 6 ÷ 4540 = 0.0017

14

REACH 14 LENGTH = 7100' $\frac{970}{210}$ $\frac{970}{385}$

CROSS SECT. $\frac{1060}{0}$ $\frac{980}{150}$ ^ $\frac{960}{200}$ $\frac{960}{375}$ ^ $\frac{980}{550}$ $\frac{1000}{700}$

SLOPE: RE. 13 INV. - RE. 14 INV. = h ÷ L = SLOPE
980 − 960 = 20 ÷ 7100 = 0.0028

CONTINUED ON SHEET 5

JOHNSONVILLE DAM

REACH ~~15~~ 13 LENGTH = 3800'

CROSS SECT. 962/0   960/500   956/672   948/680   948/855   956/863   960/930   974/1100

SLOPE: RE. 14 INV. − RE. 15 INV. = h ÷ L = SLOPE
960 − 948 = 12' ÷ 3800 = 0.0032

REACH ~~14~~ LENGTH = 3300'

CROSS SECT. 946/0   946/816   942/850   942/1025   946/1029   960/1530   1000/2100   1000/2101

SLOPE: RE. 15 INV. − RE. 16 INV. = h ÷ L = SLOPE
948 − 942 = 6' ÷ ~~946~~ 3300 = ~~0.0063~~ 0.0018

REACH ~~17~~ 15 LENGTH = 3000'

CROSS SECT. 1000/0   960/170   945/2342   937/2350   937/2550   945/2558   960/2800   1000/2900

SLOPE: RE. 16 INV. − RE. 17 INV. = h ÷ L = SLOPE
942 − 937 = 5' ÷ 3000' = 0.0017

REACH ~~18~~ 16 LENGTH = 3300'

CROSS SECT. 1000/0   940/500   941/1300   940/1701   931/1710   931/1885   940/1894   980/2700

SLOPE: RE. 17 INV. − RE. 18 INV. = h ÷ L = SLOPE
937 − 931 = 6 ÷ 3300 = 0.0018

CONTINUED ON SHEET 6

BY D. . . DATE 1/3/81 **ERDMAN, ANTHONY, ASSOCIATES** SHEET 21 OF 24

CKD ... DATE 6/4/81 SUBJECT DAM TO ROUTING SUB-SHEET NO. 6

OWNER PROJECT NAME HEC-1 DB DAM INSPECTION 60166-00.10

SPRINGVILLE DAM

REACH ~~19~~ 17 LENGTH = 1700'

CROSS SECT.	980	940	935	928	928	935	940	98.
	0	1200	1800	1907	1932	1959	2200	230

SLOPE. LE. 13 INV. - RE. 17 INV. = h ÷ L = SLOPE

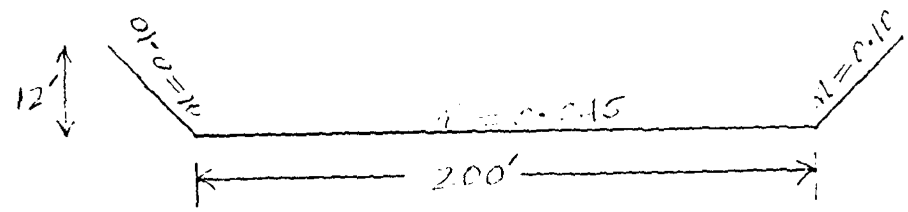
931 - 928 = 3 ÷ 1700 = 0.0018

BY E.R. DATE 2-7-1981 **ERDMAN, ANTHONY, ASSOCIATES** SHEET 22 OF 24

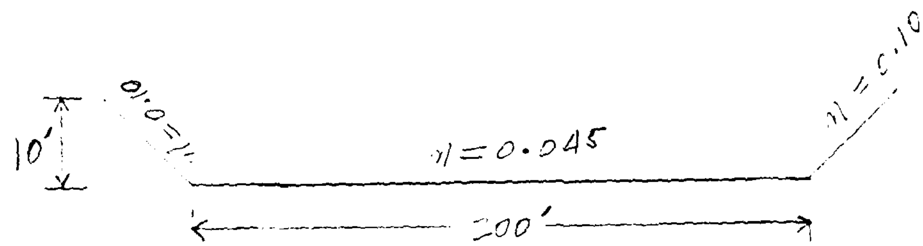
CHKD NRA DATE 6/23/81 SUBJECT DAM 704 Down Stream Cross Section SUB-SHEET NO. 1

OWNER PROJECT NAME DAM INSPECTION 40166-00.10

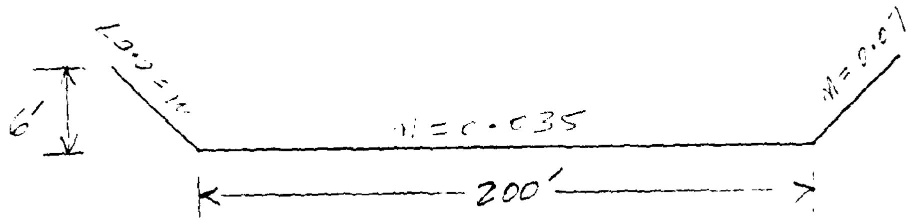
SECTION 1



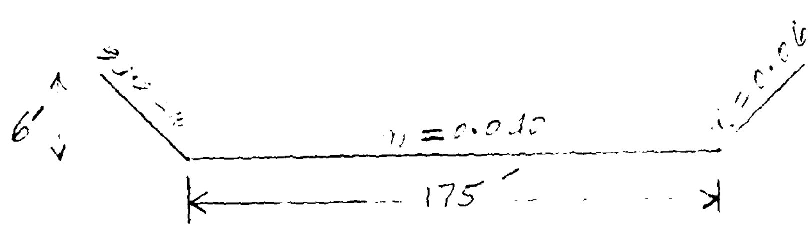
SECTIONS 2, 3



SECTIONS 4 & 5



SECTIONS 6 & 7

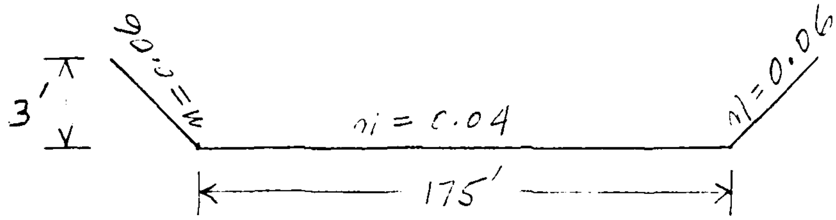


BY B.R. DATE 6-9-1981 **ERDMAN, ANTHONY, ASSOCIATES** SHEET 23 OF 24

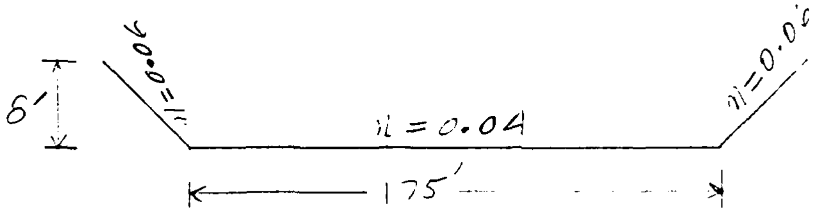
CKD DATE 6/23/81 SUBJECT DAM 704, Cross-Sections SUB-SHEET NO. 2

OWNER PROJECT NAME DAM INSPECTION 10122-0010

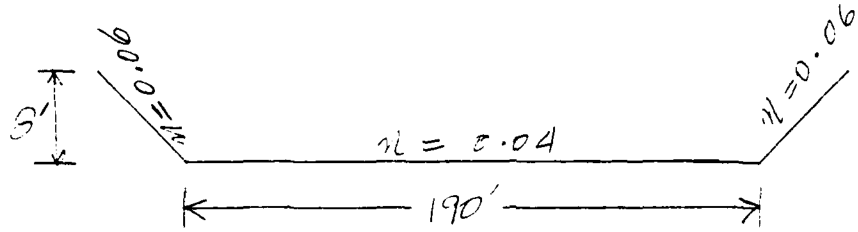
SECTION 8



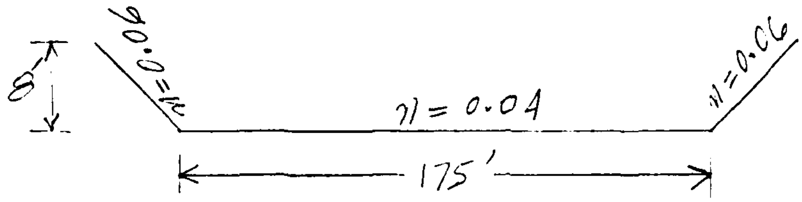
SECTION 9



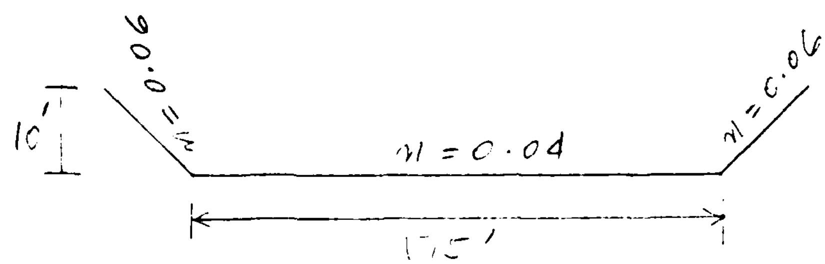
SECTION 10



SECTION 11

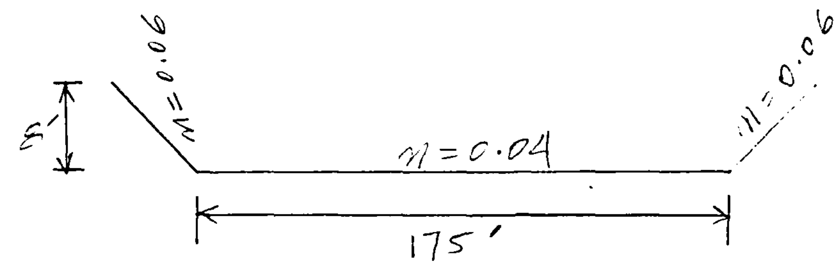


SECTION 12

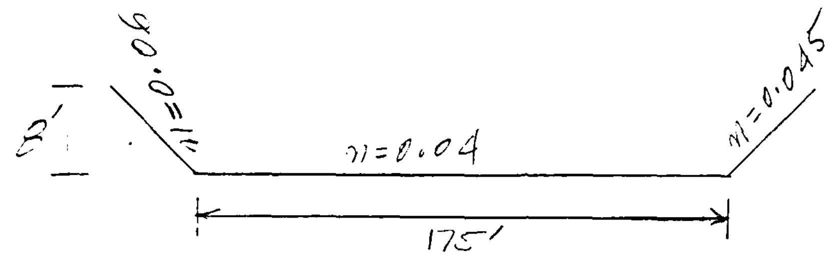


BY	DATE	ERDMAN, ANTHONY, ASSOCIATES	SHEET 24 OF 24
KD YRA	DATE 6/23/81	SUBJECT DAM 754 DOWNSTREAM CROSS SECTIONS	SUB-SHEET NO. 3
OWNER		PROJECT NAME DAM INSPECTION	80166-0010

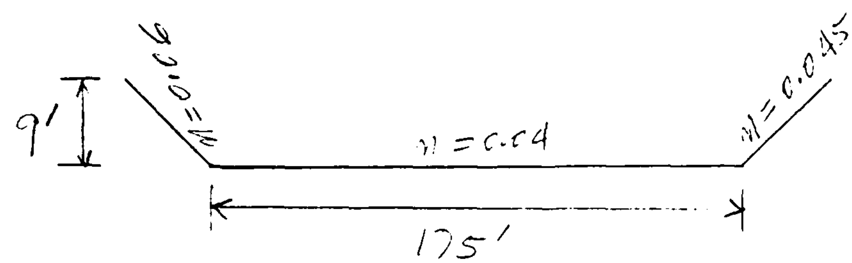
SECTIONS 13 & 14



SECTIONS 15 & 17



SECTION 16



CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

(DAM NY 704)

AREA-CAPACITY DATA:

	Elevation (ft.)	Surface Area (acres)	Storage Capacity (acre-ft.)
1) Top of Dam (west core wall)	1106.1	92	1170
2) Design High Water (Max. Design Pool)	1106.7	—	1230
3) Auxiliary Spillway Crest	1103.8	—	840
4) Pool Level with Flashboards	1096.5	—	140
5) Service Spillway Crest	1093.7	22	52

DISCHARGES

	Volume (cfs)
1) Average Daily	unknown
2) Spillway @ Maximum High Water (Top of West Core Wall)	31,550
3) Spillway @ Design High Water	33,867
4) Spillway @ Auxiliary Spillway Crest Elevation	23,192
5) Low Level Outlet (powerhouse - not operational during floods)	0
6) Total (of all facilities) @ Maximum High Water	32,000
7) Maximum Known Flood (reservoir elev. = 1100.7)	14,251
8) At Time of Inspection (reservoir elev. = 1093.7)	0

CREST: (west core wall) ELEVATION: 1106.1

Type: broad crested; earth embankment w/ core wall

Width: 1.5' Length 69.5 ft.

Spillover service spillway

Location west end of dam

SPILLWAY:

SERVICE		AUXILIARY (east core wall + 17.8' opening in core wall)
1093.7	Elevation	1105.6
Ungated Ogee Crest	Type	broad crested
182 ft.	Width	118.5 ft.
	Type of Control	
✓	Uncontrolled	✓
	Controlled:	
	Type (Flashboards; gate)	Flashboards @ elev. 1103.8
	Number	1
	Size/Length	
	Invert Material	
	Anticipated Length of operating service	17.8 ft.
N/A	Chute Length	
vertical upstream face of dam	Height Between Spillway Crest & Approach Channel Invert (Weir Flow)	5 ft.

HYDROMETEROLOGICAL GAGES:

Type : None

Location:

Records:

Date -

Max. Reading -

FLOOD WATER CONTROL SYSTEM:

Warning System: None

Method of Controlled Releases (mechanisms):

None at high flows. At low flows powerhouse intake controls reservoir elevation.

DRAINAGE AREA: 280 sq. mi.

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: minor development, woods and pastures.

Terrain - Relief: rolling plateau

Surface - Soil: glacial till over shallow bedrock

Runoff Potential (existing or planned extensive alterations to existing (surface or subsurface conditions)

None

Potential Sedimentation problem areas (natural or man-made; present or future)

About 5 ft. of sedimentation has occurred in the reservoir.

Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

None

Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

Location: None

Elevation:

Reservoir:

Length @ Maximum Pool ±2.4 (Miles)

Length of Shoreline (@ Spillway Crest) ±30 (Miles)

APPENDIX E

REFERENCES

APPENDIX E

REFERENCES

1) U.S. Department of Commerce, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, May, 1961.

2) F.M. Henderson, Open Channel Flow, Macmillian Publishing Co., Inc., 1966.

3) H.W. King and E.F. Brater, Handbook of Hydraulics, 5th Edition, McGraw-Hill, 1963.

4) T. W. Lambe and R.V. Whitman, Soil Mechanics, John Wiley and Sons, 1969.

5) W.D. Thornbury, Principles of Geomorphology, John Wiley and Sons, 1969.

6) University of the State of New York, Geology of New York, Education Leaflet 20, Reprinted 1973.

7) Cornell University Agriculture Experiment Station (compiled by M.G. Cline and R.L. Marshall), General Soil Map of New York State and Soils of New York Landscapes, Information Bulletin 119, 1977.

8) U.S. Department of Commerce, Hydrometeorological Report No. 33, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas From 10 to 1000 Square Miles and Durations of 6, 12, 24, and 48 hours, April 1956.

9) U.S. Department of the Army, Engineering Manual 1110-2-1411, Standard Project Flood Determinations, March 1952.

10) U.S. Army Corps of Engineers, The Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1) Users Manual for Dam Safety Investigations, September, 1978.

APPENDIX F

PREVIOUS INSPECTION REPORTS/
AVAILABLE DOCUMENTS

FEDERAL ENERGY REGULATORY COMMISSION
NEW YORK REGIONAL OFFICE
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

MAR 27 1980

March 21, 1980

L. ERIE 565

19A 565
NY ~~745~~ 704

Mr. George Koch
Supervisor, Dam Safety Section
N.Y. State Department of
Environmental Conservation
50 Wolf Road
Albany, N.Y. 12233

Re: The Village of Springville, NY
Dam and Hydro Works - LP No. 2802

Dear Mr. Koch:

We wish to advise that the referenced application for FERC minor license has been dismissed by order of the Commission dated November 30, 1979. The application was dismissed for lack of jurisdiction.

The Springville Project consists of a concrete dam approximately 25-feet high, a reservoir containing minimal storage, conduits, flume, a brick powerhouse containing two units with a total capacity of 500 kw and appurtenant facilities.

As the FERC no longer has jurisdiction at this facility, this matter is referred to your office for appropriate considerations.

Sincerely,

James D. Hebson

James D. Hebson
Regional Engineer

DAM INSPECTION REPORT
(By Visual Inspection)

Dam Number	River Basin	Town	County	Hazard Class	Date & Inspector
565	LK ERIE	CONCORD	ERIE	C	8/15/77

Stream = CATTARAUGUS CREEK Owner = Village of Springville

Type of Construction

- ☐ Earth w/Concrete Spillway
- ☐ Earth w/Drop Inlet Pipe
- ☐ Earth w/Stone or Riprap Spillway
- ☒ Concrete
- ☐ Stone
- ☐ Timber
- ☐ Other ______

Use

- ☐ Water Supply
- ☒ Power Village Power Supply
- ☐ Recreation - ☐ High Density
- ☐ Fish and Wildlife
- ☐ Farm Pond
- ☐ No Apparent Use-Abandoned
- ☐ Flood Control
- ☐ Other ______

420 Acre Ft.

Estimated Impoundment Size 22 Acres at spillway 42 Acres at high water Acres Estimated Height of Dam above Streambed 30 Ft.

Condition of Spillway Penstock to Power plant

☒ Service satisfactory ☒ Auxiliary satisfactory
☐ In need of repair or maintenance ☐ In need of repair or maintenance

Explain: ______

Condition of Non-Overflow Section

☒ Satisfactory ☐ In need of repair or maintenance

Explain: ______

Condition of Mechanical Equipment

☒ Satisfactory ☐ In need of repair or maintenance

Explain: ______

Siltation ☐ High. ☐ Low

Explain: ______

Remarks: C HAZ. Bridge 500' downstream.
Several homes in Flood plain 1-3 miles downstream

Evaluation (From Visual Inspection)

☐ Repairs req'd. beyond normal maint. ☒ No defects observed beyond normal maint.

EDWARDS AND MONCREIFF, P. C.

ENGINEERS AND SURVEYORS

LEE S. EDWARDS, P. E. & L. S.
ILLEN D. MONCREIFF, JR., P. E.
IANK J. JANER, P. E.
ROGER C. BURGESON, P. E.

482 S. CASCADE DRIVE
ROUTE 219
SPRINGVILLE, N. Y. 14141
716 592-2851

April 8, 1977

565 Erie

Mr. Stanfield Zoccollo, P.E.
N.Y.S. Department of Environmental Conservation
Room 414
50 Wolf Road
Albany, New York 12233

RE: Village of Springville
Dam on Cattaraugus Creek

Dear Mr. Zoccollo:

We appreciate your efforts earlier this year in researching the files relative to the Springville Dam. We have now put together a set of prints consisting of 25 sheets some of which we obtained from you and some from other sources. We are transmitting herewith one set of prints to you for your records. These should provide a much more legible and more complete record for your office.

Again we appreciate your past efforts and hope these prints will be of some value.

Flat Map C & E

Very truly yours,
EDWARDS & MONCREIFF, P.C.

Lee S. Edwards, P.E.
President

LSE/dss
Enc.
cc: Gail Dayton

CHW/K.

September 22, 1921.

Mr. [illegible] J. Cady,
Village Clerk,
Springville, N. Y.

Dear Sir:-

We have received from Village Engineer H. L. Botsford drawing #6 which has been substituted for sheet #5 showing the reinforced concrete forebay in Dam #565 Erie Watershed near Springville.

The revised plan is approved in so far as the matter involves the jurisdiction conferred upon this office by Section 22 of the Conservation Law.

Careful inspection of the work should be made, for the reason that the safety of the forebay depends largely on good workmanship. The steel should be placed to form beams where concentrated loadings occur, especially above and below the gates of the West wall. All of the walls should be well tied together either by bending the reinforcement or by placing additional short steel guards at the corners. We would recommend also that another 1¼" square bar be placed in the outside face of Bend A of the North wall.

Yours very truly,

FRANK M. WILLIAMS,
State Engineer.

By ....
Deputy State Engineer.

Cq. L
H L Botsford

Sept. ... ...

Corrugated Bar Company, Inc.
Mutual Life Building
Buffalo, N.Y.

CORRUGATED BAR
THE STANDARD CONCRETE REINFORCEMENT

CABLE ADDRESS "CORRBAR"

September 13, 1921.

Mr. Alexander R. McKinn,
Inspector of New York State Docks & Dams,
Conservation Commission,
Albany, N. Y.

Dear Sir:

Mr. H. L. Botsford, an engineer of Springville, N.Y. who is in charge of the erection of a new dam at this point, has requested us to prepare a design for a four-bay to be used in connection with this dam. We made our design and submitted copies of it to him yesterday. He requested that copies of our drawing be sent you for your reviewal. These two blue prints are being sent you today by first class mail, and we trust will reach you promptly.

In making a design for this four-bay, several assumptions in regard to pressures and stresses can be made. We used what we term a conservative basis in designing this structure. The steel stress was kept within 10,000 pounds per square inch and the concrete stress does not exceed 500 pounds per square inch in cross bending.

You will note from the plans that we have designed the structure so that the main reinforcing steel will be in a horizontal position. This method gives exceptionally short spans for the thick walls. By framing the structure in this manner additional strength is obtained thru arch action, which additional strength, however, is not taken into account. We are attaching a copy of our design for the south wall and the east wall. These two calculations will give you our methods and we believe that you will agree with us in this connection.

The structure is assumed to be empty and the water level on the outside is taken to the very top. This water pressure exists on the west wall and also on the south wall. The south wall has an earth embankment against it and is not supposed to receive any water pressure from the outside. However, we have assumed that it might receive this pressure in view of the fact that the core wall does not ward it off.

The east wall and the north wall, as well as the south wall, are assumed to take a full head of water pressure from the inside, in which case the earth pressure from the outside is entirely neglected.

The writer was at the building site yesterday and found the contractor in a position where he is ready to erect this four-bay. Won't you therefore kindly write Mr. Botsford as soon as you have gone over these plans. If there are any points which we have not made clear, or upon which you desire more explanation, do not hesitate to call on us.

We thank you for your attention and trust that you can go over this proposition promptly.

Very truly yours,

CORRUGATED BAR COMPANY, Inc.

A P Skaer

Assistant Chief Engineer

APS G

STATE OF NEW YORK
DEPARTMENT OF STATE ENGINEER AND SURVEYOR
SENIOR ASSISTANT ENGINEER'S OFFICE

TESTING LABORATORY
STATE ENGINEER'S DEP'T
ALBANY, N. Y.

Sept. 6, 1921.

MEMORANDUM ON SAMPLES OF SAND AND GRAVEL PROPOSED FOR USE ON DAM AT SPRINGVILLE, N. Y., ON THE CATTARAUGUS CREEK.

We have received two samples of sand and gravel from the Village of Springville, N. Y., which are proposed for use on a dam on the Cattaraugus Creek.

The enclosed report on the results of tests of the first sample shows that the sand and gravel contains a large percentage of loam. Except for this the materials would be satisfactory for use in concrete. But because of the large amount of loam the sand and gravel should be washed before being used.

A small second sample of sand and gravel was received from the same village. The sample was too small for tests. An examination of it, however, shows that it is composed of the same type of materials as is the larger sample, that it does not contain quite as much loam but would also have to be washed before being used.

Yours very truly,

Russell S. Greenman

Sen. Asst. Engineer,
in charge of tests.

DEPARTMENT OF STATE ENGINEER AND SURVEYOR
TESTING LABORATORY
ALBANY

Tests of Sand from Village of Springville ~~bank at~~ Springville N. Y.,
for use on Contract ~~No.~~ Dam at Springville, on Cattaraugus Creek Western Division.
~~Contract~~ Sample No. 121 taken ; received at Laboratory ; made up Aug 26
Sand is 53.8% of sample. Sand is composed mainly of coarse grains of sandstone, siltstone, limestone and fine grains of quartz and feldspar — all coated with loam.
Percentage of Voids 32.8 ; Loam 11.2 ; Organic matter Trace
Parts of sand to cement by weight ~~bulk~~ :— 3 sand to 1 cement. Per cent water used
Temperature of water used in mixing 71° Fahr. Briquettes kept in moist air 24 hours and then immersed.
Cement used in tests "Standard" Blend. This cement tested as follows:—
Sets (determined by Vicat needle):—Initial, in 155 min. (Minim. requirement 45 min.); hard, in 320 min. (Max. requirement 600 min.)
Constancy of Volume Tests:—Normal air Good ; Normal water Good ; Accelerated Good
Fineness (per cent passing standard sieve No. 100) 97.8 (Requirement, 92%)
" (" " " " No. 200) 81.8 (Requirement, 78%)

TENSILE STRENGTH IN POUNDS PER SQUARE INCH						SIZE OF SAND	
STANDARD SAND		NATURAL SAND		WASHED SAND		PASSING SIEVE	
7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	No.	Per Cent
321	454	286		318		4	100.0
320	460	264		320		6	93.2
292	462	270		312		10	79.6
294	450	276		306		20	52.0
318	448	275		304		30	29.6
1545	2274	1371		1560		40	15.0
309	455	274		312		60	8.6
						74	6.0
						100	3.6
						140	2.6
						200	2.0

Remarks: Gravel is composed mainly of small pebbles of sandstone, limestone, calcite and shale — all coated with loam.

I CERTIFY that this is a true abstract taken from the records of tests Sept 6 1921

Russell S. Greenman
Sr. Ass't Engineer in Charge of Tests

AEMcK-H

Dam 565
Erie Watershed
Village of Springville

September 3, 1921

Mr. P. J. Cady,
Village Clerk,
Springville, N. Y.

Dear Sir:-

We have received ffom your Village Engineer, H. L. Botsford, drawings 1, 2, 3, 4 and 5 for Dam No. 565, Erie Watershed at Springville, owned by the Village of Springville. The forebay drawing on sheets Nos. 1, 2 and 4 are superseded by sheet No. 5.

On August 15th we approved of the dam and apron section of the application which are shown on drawings 2 and 3. We hereby approve of the west abutment and embankments shown on drawing No. 4 and the penstock forebay and east abutment as shown on drawing Nol 5. This completes application No. 426 which has been submitted.

This approval shall not be deemed to authorize any invasion of property rights, either public or private, in carrying out the above work; nor to create any claim or demand against the State of New York; nor to be considered as authorizing the flooding of State lands, nor as acquiescing in the flooding of such lands.

If flashboards are to be used in the spillway, they should be so designed as to give way entirely when the pond level reaches two-thirds the height of the spillway so that the whole spillway may be available for floods. The design of these flashboards, giving the span and dimensions, should be submitted to and approved by this office before they are used.

Please acknowledge the receipt of this letter promptly.

Very truly yours,

Frank M. WILLIAMS

State Engineer

By ....

Deputy State Engineer

Copy for-

ARMcK-F.

Approval of Dam #565,
Erie Watershed,
Springville, N. Y.

September 3, 1921.

Hon. Frank M. Williams,
State Engineer and Surveyor,
Albany, N. Y.

Dear Sir:-

On August 15th, you approved of the dam and apron section for this application. The unapproved portion has been very carefully studied and checked up. The penstock forebay particularly has been given considerable time and attention as it had to be gone over several times on account of inadequate reinforcement and poor design. Assistant Engineer Gibson has checked this over and done good work thereon. The site has been inspected by Senior Assistant Engineer Wildes on the foundation bed.

I consider the entire dam as now shown by the plans submitted to have ample provisions for the protection of life and property below the dam and therefore respectfully recommend your approval.

Very truly yours,

Inspector of Docks and Dams.

August 18, 1921.

Mr. L. C. Hulburd,

Division Engineer,

Rochester, N. Y.

19A 565
NY 704

Dear Sir:-

On August 15, in company with the local engineer, Mr. H. L. Botsford, I inspected the foundations of the proposed dam of the Springville Municipal plant. This is being located about 60 feet below the old timber spillway dam, and extends east and west across the lower end of a gorge in Cattaraugus Creek. A concrete Ogee section for about 182 feet (same length as old spillway), concrete abutments tying in with old stone masonry abutments and clay dikes, with concrete core walls extending into each hillside and utilizing the old dikes as upstream bermes will comprise the structure. The rock foundation is a generally firm and well preserved shale which, where long exposed on the hillsides, has rotted and scaled conspicuously. Where cleaned off in the stream-bed, it exhibits approximately horizontal cleavage, occasionally intersected by vertical cleavage planes. There is enough evidence of water action to indicate that the rock will stand considerable attrition before shattering along cleavage planes.

The entire cross-section of the stream-bed has scoured to a depth of about 7 to 20 feet, on account of the overflow at the old spillway. The down-stream edge of this pocket has been utilized as a toe-hold for the new structure. Thus it is planned to build this dam on the existing surface with necessary cleaning up by hand tools and very little drilling or excavation, and I concur in Mr. Botsford's view that, where avoidable, it is distinctly better not to blast and disturb existing surface. No cut-off is planned at the up-stream side or under the apron.

The Walter Bradley Construction Co., Contractors, have installed a concrete plant and chute, and prepared the foundation of the most westerly section of spillway (which is to be 45 feet long), except for drilling and cutting into the hillside, so as to square the excavation at the deeper level, westerly to the abutment. Since the up-stream face of the new dam is near the middle of the pocket in the stream-bed, the horizontal seams would be exposed to water pressure below the level of the stream-bed at the ends of the hole and, also, in the center of the valley where the hole is deepest up-stream from the dam. These exposed surfaces at the ends, it is proposed to seal with concrete extending up-stream from the structure, and the rock had already been prepared for this at the west end. The question of lining the deeper hole at the center with concrete was

being considered and I recommended its adoption.

I was asked particularly to pass on the foundation as prepared, for the westerly block. The lower level was flat, clean and firm at an elevation about 7 feet below the normal stream-bed. The irregular step and higher level satisfied me, although there were two close vertical seams or cleavage planes extending through the section at 45° with the dam. A similar seam has widened into a small channel in the creek below here and these seams may carry some leakage and in time need attention. No explotatory holes have been drilled here; but the evidence of the old dam which has stood over twenty years with only three foot lower crest, is reasonable assurance that there are no serious sub-foundation difficulties. I therefore informed Mr. Botsford that I should report the foundation as satisfactory for this section, excepting the west end, still to be excavated. In so reporting I understand that the dam has been figured to resist upward pressure.

The general plan for the remainder of the spillway foundation appears to me adequate; but if complete inspection is required, it will be necessary to pass on the sections separately-it being the intention to have another one ready in a few days.

In regard to the clay section of dam, I would say the valley soil appears to be good clay. Abundant gravel may be had if desired from the hilltops, and I would suggest that this be mixed with the clay especially on the down-stream side. It was Mr. Botsford's intention to excavate the corewall foundation a little into rock, but using possibly 12-inch steps. I recommend at least 5-foot steps and a 2-foot minimum cutting. The natural rock here slopes about 1 on 1 where exposed on the west hillside.

The watershed, Mr. Botsford stated to be about 285 square miles, reservoir area some 40 acres. Greatest height of flow on the old dam about 10 feet or nearly to the point of overtopping. The new dam provides for 14' on crest before overtopping; but the computations were said to be figured on basis of 10' overflow and provide for 43000 c.f.s. or 150 sec. ft. per sq. mile. This would seem, however to provide for less than 20000 c.f.s. or for some 30000 c.f.s. with 14' head. The recorded gagings below at Versailles, when prorated according to drainage areas, would indicate less than 20000 c.f.s. flood at Springville.

The height of crest above river bed (nearly 30 ft.), the amount of overflow and the extent of the scour below ~~the old~~ dam, namely, about 60 ft., would seem to indicate that the 24-foot apron as planned is none too long for secutiry.

Very truly yours,

Waldo G. Wildes

Senior Assistant Engineer.

WGW/W

ARMoK-F.

In re Dam 565,
Erie Watershed,
Cattaraugus Creek.

August 15, 1921.

Mr. H. L. Botsfort, Village Engineer,
Village of Springville,
Springville, N. Y.

Dear Sir:-

We have received the application, together with sheets Nos. 1, 2 and 3 and a survey sheet dated July 19th, for the reconstruction of Dam No. 565, Erie Watershed, on Cattaraugus Creek at Springville, owned by the Village of Springville, which we approve for the dam and apron section and permission to November 1, 1922, is given for the construction of this part of the dam in accordance with the said plans. Additional plans must be submitted for approval for the forebay and the earth embankment. For the core wall of the earth embankment we sugges a top width of at least 18 inches and a batter of 1/2 horizontal to 12 vertical on each side. The trench for this core wall should be dug into the natural bed for a depth of 6 feet and entirely filled with the concrete core base.

This dam section is approved in so far as the matter involves the jurisdiction conferred upon this office by Section 22 of the Conservation Law. This approval shall not be deemed to authorize any invasion of property rights, either public or private, in carrying out the above work; nor create any claim or demand against the State of New York; nor to be considered as authorizing the flooding of State lands, nor in acquiescing in the flooding of such State lands.

Very truly yours,

FRANK M. WILLIAMS,
State Engineer,

BY ______________________
Deputy State Engineer.

AEMcK-F.

August 15, 1921.

Hon. Frank M. Williams,
State Engineer,
Albany, N. Y.

Dear Sir:-

The Village of Springville has submitted an application and plans for the reconstruction of their dam No. 565, Erie Watershed on Cattaraugus Creek. The drainage of the pond formed by this dam is about 280 square miles - this section of the State is unmapped. The probable maximum flow would be 30800 feet and would overflow the crest of the spillway at a height of 13 feet. The abutment of the old dam was 10 feet and of the proposed dam 14 feet so that the spillway will be ample to take this flood. The forces for this resultant are well within the middle third.

I find the dam as proposed to have ample dimensions for the protection of life and property and therefore respectfully recommend your approval.

Very truly yours,

Inspector of Docks and Dams.

Form W-97
Acc. 980

Filed ______ 19____ (Springville) Dam 565 Watershed Erie

Disposition Approved 15 Aug 1921 Serial No 426

Inspected site ______ 19____

Foundation seen ______ 19____

Construction O. K. ______ 19____

APPLICATION FOR CONSTRUCTION OR RECONSTRUCTION OF A DAM

______ (Address of Applicant)

Application is hereby made to the Conservation Commission of the State of New York, in compliance with the provisions of Chap. LXV of the Consolidated Laws, the Conservation Law, for approval of the detailed specifications and plans, marked Springville Dam Sheets 1 & 3

herewith submitted for the { ~~construction~~ reconstruction } of the dam located as stated below. All provisions of law will be complied with in the erection of the said dam.

LOCATION AND GENERAL DATA

Site of dam on Cattaraugus (Name of stream)

a branch of Lake Erie (Name of stream) within the limits of the town of Ashford, Cattaraugus Co. ~~Concord~~, Erie Co County of Cattaraugus ~~and~~ Erie.

Dam is 500 ft above "Scobey" Bridge on the road between Springville (Give approximate distance from well-known bridge, dam, village or mouth of stream, so that the exact site may be readily located on map of the State) and East Otto, and about 2½ miles from the Village of Springville.

Purpose of dam Hydro Electric Plant of Village of Springville

Reasons for making changes in existing structure Present timber dam badly decayed.

Aug 10, 1921 (Date)

{Signature of applicant} Village of Springville

H.L. Botsford – Village Engineer
(A person executing for Applicant should indicate his title or authority)